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current account deterioration and a rise and fall of the
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Boom-and-bust cycles marked by capital inflows, current account deterioration and a rise and fall of the real exchange rate

Nikolas A. Müller-Plantenberg*

Abstract

When the current account balance and net capital outflows do not exactly offset each other, net payment flows arise. Payment inflows into a country push the real exchange rate up, outflows push it down. This paper uses a model of optimal consumption and portfolio choice to determine the factors that drive international payment flows during boom-and-bust cycles. It shows that during such cycles, capital inflows first exceed the deficit on current account, strengthening the currency. Later on, when returns on domestic investments revert to their normal levels, the current account recovers, yet the overall decline of the international investment position provokes a fall of the real exchange rate even below its initial level. Case studies of countries experiencing rapid economic expansions followed by financial collapse confirm the paper's theoretical predictions.

JEL classification: F31, F32, F34, G01, G11, N10

Keywords: boom-and-bust cycles, optimal consumption and portfolio choice, capital inflows, current account deterioration, currency flows, crises

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1 Introduction

During the last half-century, many countries have opened up their financial accounts by removing restrictions on cross-border capital flows (Chinn & Ito 2008). As a consequence, the volume of international financial transactions and the associated stocks of foreign assets and liabilities have increased substantially (Obstfeld & Taylor 2003). Regardless of their economic benefits, capital flows can have destabilizing effects, particularly when they cause so-called boom-and-bust cycles. In the past, there have been many episodes in all parts of the world where countries that were experiencing strong capital inflows accompanied by rapid economic expansions subsequently had to endure serious economic and financial crises.

Boom-and-bust cycles share a number of common characteristics (Calvo et al. 1993, 1994, 1996, Conley & Maloney 1995, McKinnon & Pill 1996, 1997, Gourinchas et al. 2001, Tornell & Westermann 2002). The boom phase can be described as follows: First, although capital inflows can be facilitated by external factors, in most cases it is possible to find changes in a country's internal conditions—such as, for example, domestic economic reforms, moves towards more financial openness, technological innovations or natural resource discoveries—that create an optimistic atmosphere and make the country attractive in the eyes of foreign investors. The country thus enters a period of high (actual or perceived) returns on domestic real and financial assets. Second, the country starts to receive large sums of foreign investment, both in the form of equity and debt. Third, the country experiences accelerated growth and a strong surge in domestic investment. Private consumption also rises, causing national saving to stay low or to even drop. Fourth, the current account, defined as the gap between saving and investment, deteriorates steadily. Fifth, despite the deficit on the current account, the real exchange rate tends to appreciate strongly.

After reaching a peak, however, the country enters a downward spiral. First, domestic residents and foreign investors realize that their expectations were too optimistic, making stock and real estate markets plummet. Second, foreign investors turn their back on the country, pulling out their stakes. Third, the country enters recession and is possibly also confronted with a financial crisis. Domestic investment falls, and so does consumption. Fourth, the current account improves, not so much, however, as to undo the previous rise in net foreign debt. Fifth and finally, the real exchange rate falls, in many cases below its initial level.

The described causes and effects of capital inflows are not unexpected. It is relatively straightforward, for instance, to explain the first four features of each of the two respective phases, the boom and the bust, using a model of intertemporal consumption and saving in

an open economy with capital mobility (see Calvo et al. 1996). However, this article goes one step further. While constructing a model that is capable to explain the main macroeconomic fluctuations during temporary booms in foreign lending, it offers an entirely new theoretical explanation of the fifth feature, the initial rise and subsequent decline of the real exchange rate.

In accordance with traditional theory, studies of boom-and-bust cycles tend to attribute fluctuations in real exchange rates to changes in the relative price of non-traded goods. When consumption and investment rise during a boom, the argument goes, the demand for both traded and non-traded goods increases. Since the latter are in more limited supply than the former, the rise in demand will result in an increase in the relative price of non-tradables. Assuming that domestic and foreign tradables prices cannot move too far apart, the implication is that the boom country experiences a rise of its overall price level, or in other words an appreciation of its real exchange rate.

The problem with this theory is that it has little empirical support. As research initiated by Engel (1999) shows, the non-traded goods component of the real exchange rate (that is, the ratio of the relative prices of non-traded versus traded goods in both countries) does not seem to explain much of the real exchange rate changes observed in reality; instead, most of these changes appear to be driven by the traded goods component (that is, the ratio of the tradables prices of both countries, converted to the same currency using the nominal exchange rate). In his detailed study, Engel (1999) notes that although "most of the recent theoretical literature on real exchange rates has emphasized movements in the non-traded-goods component" (p. 508), the impression from the evidence is that "relative prices of non-traded goods [...] account for almost none of the movement of U.S. real exchange rates" (p. 507). Betts & Kehoe (2006, 2008) stress the sensitivity of Engel's (1999) findings to the way the relation between non-traded goods prices and real exchange rates is measured. However, studying 1225 country pairs over 1980–2005, they acknowledge that the movements of the relative price of non-traded to traded goods are smaller than those of the real exchange rate and that a large fraction of real exchange rate fluctuations is due to deviations from the law of one price for traded goods.

This article goes back to basics and assumes that the nominal exchange rate is driven by the demand and supply conditions in the foreign exchange market. Suppose for a moment that prices are stable. Then real exchange rate movements depend entirely on the nominal exchange rate (keep in mind that the traded goods component of the real exchange rate is itself often primarily accounted for by nominal exchange rate changes). The more of the *domestic* currency people hold, the less they need it—say, for transaction purposes—and the *lower* will be its exchange rate (its price in terms of the foreign cur-

rency); conversely, the more of the *foreign* currency people hold, the *higher* will be the relative value of the domestic currency and thus its exchange rate.

The key question is why people hold certain amounts of different currencies. This article shows that the answer is straightforward as long as one avoids a very common economic fallacy that affects much of the research and teaching in international finance. The balance of payments is an accounting identity, meaning that the current account and the financial account sum up to zero (for simplicity, we ignore here the capital account, which records non-market and other special transactions, as well as the errors and omissions category of the balance of payments). Many economists wrongly take this to mean that the current account, net capital inflows and net sales of official reserves would also have to add up to zero. The truth is that the sum of these three items generally differs from zero because a country's financial account does not only include capital flows and official reserve changes, but also monetary payments the country makes and receives.

It is useful to recall the general rule whereby outflows of financial assets are recorded as credits in the financial account and inflows of financial assets as debits. Technically, capital inflows are *outflows* of ordinary (that is, non-monetary and non-reserve) financial assets and thus are recorded as credits in the financial account, whereas capital outflows are *inflows* of ordinary financial assets and recorded as debits. With money and reserve flows, the accounting rule mentioned above implies that money and reserve inflows are debits and that money and reserve outflows are credits. Money flows, which we will also refer to as currency or payment flows, are recorded in the "other investment" rubric of the financial account. However, "other investment" also includes other items, such as trade credits and bank loans. Yet published balance of payments statistics hardly ever distinguish between the different types of "other investment", so that in general it is impossible to learn anything about money flows from the available data, a problem to which we will return when studying historical cases of boom-and-bust cycles in section 5.

Accepting that international payment flows exist and that they are important for exchange rates implies the need to model the current account and capital flows independently. This is what is done in this article and what sets this article apart from almost all theoretical models in international macroeconomics since these models generally assume, explicitly or implicitly, that capital flows follow the movements of the current account or vice versa.

This article builds a model of optimal consumption and portfolio choice in an open economy. Among other assets, the representative consumer-investor holds money. However, the amount of domestic and foreign money he or she holds depends on the accumulated money flows between his or her country and the rest of the world—and thus on all present and past current account balances, financial flows and reserve interventions. The

model is used to study the macroeconomic dynamics of a country whose asset returns initially rise and subsequently fall back to their original levels. It is shown how at the beginning capital inflows rise and the current account deteriorates due to the boom in consumption and investment and also because of rising interest and dividend payments; later on, capital inflows slow down and the current account recovers. For the exchange rate, the movements of the different balance of payments components imply an appreciation during the upswing, followed by an even greater depreciation during the downswing.

The paper is structured as follows: Section 2 reviews the literature and shows how ideas of earlier economic models have been incorporated into the present study. Section 3 presents the model of optimal consumption and investment and explains how the nominal and real exchange rates are determined by the movements of the balance of payments. Section 4 simulates the behaviour of the model during a typical boom-and-bust cycle. Section 5 provides case studies that show that the model can be applied to many different historical episodes. Finally, section 6 provides conclusions.

2 Literature review

To understand the origins of this article, section 2.1 shows how previous models in the international economics literature have paved the way to the theory developed in this article. Section 2.2 then outlines connections between this article and related research areas.

2.1 Preceding models

Table 1 summarizes several important features of theoretical models that are closely related to, and have had a certain influence on, the model presented in section 3. These models can be classified into three groups.

First, there are theories of the behaviour of the current account. The intertemporal approach to the current account, for instance, was made popular by Obstfeld & Rogoff (1995, 1996), even though the basic intuition existed before (see, for example, Sachs 1982). According to this theory, temporary income shocks are saved and invested abroad, giving rise to current account surpluses in case of positive shocks and deficits in case of negative ones. More recently, Kraay & Ventura (2000, 2003) have modified this theory arguing that when consumers save income shocks to smooth their consumption, they will allocate the additional savings between domestic capital and foreign assets based on an assessment of risk and return. Kraay & Ventura (2000, 2003) derive what they call the new rule of the current account according to which a country's current account response equals the saving generated by the shock times the ratio of net foreign assets to wealth.

	Boom-and-bust cycles	Consumption and saving	Real investment	Current account (BoP)	Financial investment flows (BoP)	Money flows (BoP) and FX market	Microeconomic underpinning
Obstfeld & Rogoff (1995)		•		•	•		•
Kraay & Ventura (2000)		•	•	•	•		•
Conley & Maloney (1995)	•	•					
McKinnon & Pill (1996, 1997)	•	•					
Hau & Rey (2006)				○	•	•	•
Müller-Plantenberg (2006, 2010)				•	•	•	
Present study	•	•	•	•	•	•	•

Table 1: Theoretical components of the present study and of related earlier analyses.

The model developed in this article builds on these approaches to current account determination. However, it shows that when positive income shocks are caused by rising asset returns, the surge in domestic investment implies an unambiguous worsening of the current account (rather than an improvement as the standard intertemporal approach predicts). Another distinguishing feature of the model presented here is that a country's current account and net capital outflows are determined independently. This gives rise to international payment flows, a feature that is entirely absent from the conventional theories of the current account.

Second, there are many models of boom-and-bust cycles in the literature. Of particular relevance for this article are Conley & Maloney (1995) and McKinnon & Pill (1996, 1997) who show how boom-and-bust cycles can occur when economic reforms raise the level and variance of the payoffs to new investments. Their modelling approach is similar to the one adopted in this paper, which supposes that an economic boom and subsequent financial crash are the result of a temporary increase in the returns on domestic assets. However, the model of this paper goes one step further insofar as it presents a coherent explanation of why the real exchange rate rises and falls in response to higher than normal asset returns.

Third, there are models that link exchange rate fluctuations to balance of payments movements. However, these models are very small in number and all have their shortcomings. The idea that balance of payments fluctuations give rise to flows of money between countries is an old one. After all, the theory of the price-specie flow mechanism under a gold standard developed by David Hume in the 18th century builds on it. Early analyses of the effect that current account imbalances have on the exchange rate were carried out by Robinson (1937) and Machlup (1939, 1940). In the recent past, hardly any work has been done to understand the influence of balance of payments movements on exchange rates, notable exceptions being the studies by Hau & Rey (2006) and Müller-Plantenberg (2006, 2010). Hau & Rey (2006) build a model of capital and dividend flows and their effects on the nominal exchange rate. However, except for the dividend flows, their model does not allow for any current account movements, setting it thus apart from the more encompassing model presented here. The models developed by Müller-Plantenberg (2006, 2010) do analyse the interaction between the current account, capital movements and currency flows. However, unlike the model of this article, those models lack a microeconomic motivation.

2.2 Related research

At a more general level, the present study is related to other important research areas, of which three should be mentioned here: the literature on currency crises, the micro-structure approach to exchange rate determination and the newly emerging research on international macro-finance.

The literature on currency crises is relevant for the present study since boom-and-bust cycles often result in rather sharp exchange rate depreciations, especially in countries that start off with a fixed exchange rate. This literature can be divided into theoretical and empirical studies. Theoretical research has mainly focused on the short-run causes of currency crises, such as sudden shifts in expectations, self-fulfilling beliefs or balance-sheet effects (Krugman 1979, 1999, Flood & Garber 1984, Obstfeld 1986, 1994). As regards the long-run causes of those crises, many theories rely on excessive money growth as the fundamental reason why crises occur. This article, in contrast, emphasizes the role of prolonged current account deficits in the years leading up to such crises. Interestingly, the empirical studies on currency crises, especially in the literature on so-called early warning indicators, typically do tend to include the current account in their regressions (Berg et al. 2005).

The microstructure approach to exchange rate determination analyses the determination of exchange rates in the foreign exchange markets (Lyons 2001, Vitale 2007). One important and robust finding this literature has produced is the strong correlation between

currency order flows and exchange rate changes. The relevance of this finding in the present context is obvious since the link between currency flows and exchange rate movements is a central element of this article. Nevertheless, unlike the present study, the microstructure approach typically focuses on the short-run dynamics of the exchange rate and does not analyse the relationship between high-frequency FX order flows and lower-frequency balance of payments movements.

Finally, the literature on the so-called international macro-finance aims to introduce portfolio choice and asset pricing considerations into models of international macroeconomics (Tille & van Wincoop 2010, Pavlova & Rigobon 2011). The model of this paper can be considered to form part of this new research area as it combines macroeconomic features with a problem of optimal portfolio choice in an international context.

3 Model

3.1 Notation

We use a subscript 0 to indicate a stock variable (for example k_0 , the capital stock) and a subscript 1 to indicate its first time derivative (k_1 , instantaneous investment):

$$k_1 = \frac{dk_0}{dt}. \quad (1)$$

There are two identical countries, a home and a foreign one. The home country is indexed by H, the foreign country by F. Single superscripts indicate whether a variable belongs to the home or the foreign country; for example, a_0^H , z_1^H , c_1^H and k_0^H are, respectively, wealth, the current account, consumption and the real capital stock of the home country. Double superscripts are used for financial assets in such a way that the first superscript indicates the owner of an asset and the second superscript the asset's location; for instance, e_0^{HF} and b_0^{HF} represent, respectively, foreign equity and foreign bonds (or loans) held by domestic residents. In the case of money and official reserves, the second superscript indicates the currency denomination, so that m_0^{HH} is the amount of domestic money the domestic agent holds, m_0^{HF} the amount of foreign money he or she holds, o_0^{HF} the official reserves (foreign currency) the domestic central bank has accumulated etc.

Note that the representative consumer-investor of the home country can hold only domestic real capital and its foreign-country counterpart only foreign real capital. This is because according to balance of payments accounting rules real capital belongs to the country of residence of the person who owns it. Hence k_0^{HF} and k_0^{FH} do not exist and k_0^{HH} and k_0^{FF} are written simply as k_0^H and k_0^F . Movements of real assets are recorded in the

current account of the balance of payments (in the case of land and fixed assets in the capital account, which is not to be confused with the financial account).

On the other hand, the representative consumer-investor of a given country can have net financial claims only against his or her foreign-country counterpart, since claims against himself or herself would be exactly offset by corresponding obligations (unless a government or central bank holding non-monetary assets is introduced, which is not considered here). This is why, say, b_0^{HF} and b_0^{FH} exist but b_0^{HH} and b_0^{FF} do not. Movements of financial assets are recorded in the financial account of the balance of payments.

Since both countries are identical, equations and formulae will generally be stated only for the home country. The corresponding equations and formulae of the foreign country can be derived analogously or be obtained by simply interchanging the superscripts H and F of all variables.

3.2 Optimal consumption and investment

The representative agent of the home country—and analogously the one of the foreign country—decides in each infinitesimal period how much to save and consume and how to distribute his or her stock of wealth among alternative assets. The objective is to maximize the expected present discounted value of consumption:

$$\mathbb{E} \int_0^\infty e^{-\rho t} \ln(c_{1,t}^{\text{H}}) dt. \quad (2)$$

The stocks of wealth of the domestic and foreign agents are given by the following equations:

$$\begin{aligned} a_0^{\text{H}} &= k_0^{\text{H}} + m_0^{\text{HH}} + e_0^{\text{HF}} - e_0^{\text{FH}} + b_0^{\text{HF}} - b_0^{\text{FH}} + m_0^{\text{HF}} \\ &= k_0^{\text{H}} + m_0^{\text{HH}} + z_0^{\text{H}} - o_0^{\text{HF}} + o_0^{\text{FH}}, \end{aligned} \quad (3a)$$

$$\begin{aligned} a_0^{\text{F}} &= k_0^{\text{F}} + m_0^{\text{FF}} - e_0^{\text{HF}} + e_0^{\text{FH}} - b_0^{\text{HF}} + b_0^{\text{FH}} + m_0^{\text{FH}} \\ &= k_0^{\text{F}} + m_0^{\text{FF}} + z_0^{\text{F}} + o_0^{\text{HF}} - o_0^{\text{FH}}. \end{aligned} \quad (3b)$$

where

$$\begin{aligned} m_0^{\text{FH}} &= -m_0^{\text{HF}}, \\ z_0^{\text{F}} &= -z_0^{\text{H}}. \end{aligned} \quad (3c)$$

The domestic agent chooses among three risky assets, k_0^{H} , e_0^{HF} and b_0^{HF} , and (risk-free) money, $m_0^{\text{HH}} + m_0^{\text{HF}}$. Similarly, the foreign agent chooses among the remaining three risky assets, k_0^{F} , e_0^{FH} and b_0^{FH} , and (risk-free) money, $m_0^{\text{FF}} + m_0^{\text{FH}}$. Thus there are altogether six

risky assets (domestic and foreign real capital, equity and bonds) and two non-risky assets (domestic and foreign money). Note that provided the foreign investment position, z_0^H , is known, it is possible to determine how much domestic and foreign money each agent holds; in other words, m_0^{HH} , m_0^{FF} , m_0^{HF} and m_0^{FH} are all identified:

$$m_0^{HH} = a_0^H - k_0^H - z_0^H + o_0^{HF} - o_0^{FH}, \quad (4a)$$

$$m_0^{HF} = z_0^H - e_0^{HF} + e_0^{FH} - b_0^{HF} + b_0^{FH} - o_0^{HF} + o_0^{FH}, \quad (4b)$$

$$m_0^{FH} = z_0^F + e_0^{HF} - e_0^{FH} + b_0^{HF} - b_0^{FH} + o_0^{HF} - o_0^{FH}, \quad (4c)$$

$$m_0^{FF} = a_0^F - k_0^F - z_0^F - o_0^{HF} + o_0^{FH}. \quad (4d)$$

We assume that the risk and return properties of real capital, equity and bonds can be represented by yield-less assets whose prices follow geometric Brownian motions:

$$dP_{i,t} = P_{i,t}\pi_i dt + P_{i,t}\zeta_i d\omega_{i,t}, \quad (5)$$

where $i \in \{k^H, k^F, e^{HF}, e^{FH}, b^{HF}, b^{FH}\}$. Let w_i be the share of domestic wealth allocated to asset i by the domestic agent and w_j the share of foreign wealth allocated to asset j by its foreign counterpart. It can be shown that the domestic consumer's budget equation is (see Merton 1971):

$$\begin{aligned} a_1^H dt = & \left(\sum_i (\pi_i - r) w_i a_0^H - \sum_j (\pi_j - r) w_j a_0^F + r a_0^H - c_1^H \right) dt \\ & + \sum_i w_i a_0^H \zeta_i d\omega_i - \sum_j w_j a_0^F \zeta_j d\omega_j. \end{aligned} \quad (6)$$

where $i \in \{k^H, e^{HF}, b^{HF}\}$ and $j \in \{e^{FH}, b^{FH}\}$.

To find the optimal consumption and investment rules, consider the Bellman equation for this problem:

$$\begin{aligned} \rho V(a_0^H) = & \max_{w_1^H, w_i} \left\{ u(c_1^H) \right. \\ & + \left(\sum_i (\pi_i - r) w_i a_0^H - \sum_j (\pi_j - r) w_j a_0^F + r a_0^H - c_1^H \right) V'(a_0^H) \\ & + \frac{1}{2} \left(\sum_i \sum_{i'} w_i w_{i'} (a_0^H)^2 \zeta_i \zeta_{i'} \eta_{ii'} - \sum_i \sum_j w_i w_j a_0^H a_0^F \zeta_i \zeta_j \eta_{ij} \right. \\ & \left. \left. + \sum_j \sum_{j'} w_j w_{j'} (a_0^F)^2 \zeta_j \zeta_{j'} \eta_{jj'} \right) V''(a_0^H) \right\}, \end{aligned} \quad (7)$$

where $i, i' \in \{k^H, e^{HF}, b^{HF}\}$, $j, j' \in \{e^{FH}, b^{FH}\}$, $\eta_{ii'} = 1$ if $i = i'$ and $\eta_{jj'} = 1$ if $j = j'$.

The domestic consumer-investor solves the first-order conditions with respect to c_1^H , w_{k^H} , $w_{e^{HF}}$ and $w_{b^{HF}}$:

$$u'(c_1^H) = V'(a_0^H), \quad (8)$$

$$w_i = \frac{\pi_i - r}{\zeta_i^2} \left[-\frac{V'(a_0^H)}{a_0^H V''(a_0^H)} \right] - \frac{1}{2\zeta_i^2} \left(\sum_{i' \neq i} w_{i'} \zeta_i \zeta_{i'} \eta_{ii'} - \sum_j w_j \frac{a_0^F}{a_0^H} \zeta_i \zeta_j \eta_{ij} \right), \quad (9)$$

where $i, i' \in \{k^H, e^{HF}, b^{HF}\}$ and $j \in \{e^{FH}, b^{FH}\}$. Note that the term in squared brackets is the reciprocal of the Arrow-Pratt relative risk aversion of the indirect utility function.

Equation (8) says that consumption is so chosen that, in current values, the marginal utility of consumption equals the marginal utility of wealth, which is a standard result. Equation (9) determines the optimal shares of wealth invested by the domestic consumer-investor in each of his or her risky assets. The investment in asset i depends positively on the asset's excess return over the risk-free asset (money) and negatively on the asset's variance; the more risk-averse the investor is, the weaker will be the first effect and the stronger will be the second effect. Finally, optimal diversification requires the investor to adjust his or her holdings of asset i according to the asset's correlation with other assets (i') as well as foreign financial claims (j).

As shown in appendix A, the assumption of logarithmic utility implies a value function of the following form:

$$V(a_0^H) = \frac{1}{A} \ln(a_0^H) + B, \quad (10)$$

where $A = \rho$ and B is a constant to be determined. The first-order condition for consumption in equation (8) reduces to $c = \rho a_0^H$; that is, the agent consumes a stable fraction of his or her wealth. Moreover, the degree of relative risk aversion of the indirect utility function, $\gamma(a_0^H)$, is constant and equal to one:

$$\gamma(a_0^H) = -\frac{a_0^H V''(a_0^H)}{V'(a_0^H)} = 1.$$

Hence the formula for the optimal asset shares in equation (9) is simplified and the optimal portfolio shares are independent of wealth.

3.3 Output and national income

3.3.1 Output

World output is assumed to be demand-driven and equal to the world's real consumption and investment spending.

$$\sum_i \bar{y}_1^i = \sum_i (c_1^i + k_1^i) \quad i \in \{H, F\}. \quad (11)$$

Countries are presumed to import a constant share α of their consumption and investment from abroad so that the output of the home country is determined by the consumption and investment spending in both countries as follows:

$$\bar{y}_1^H = (1 - \alpha)c_1^H + \alpha c_1^F + (1 - \alpha)k_1^H + \alpha k_1^F. \quad (12)$$

Using α , we can calculate the import share of the home country, β^H :

$$\beta^H = \frac{\alpha(c_1^H + k_1^H)}{y_1^H}. \quad (13)$$

Note that the proportion of imported goods out of consumption and investment, α , is equal to the import share, β^H , if the sums of consumption and investment are equal in both countries. However, if total consumption and investment spending in the home country differs from that in the foreign country, α and β^H will be different.

3.3.2 National income

The national income of the home country is equal to the country's output (GDP) plus the net income from financial investments abroad:

$$y_1^H = \bar{y}_1^H + \sum_i \pi_i w_i a_0^H - \sum_j \pi_j w_j a_0^F + r m_0^{HF}, \quad (14)$$

where $i \in \{e^{HF}, b^{HF}\}$ and $j \in \{e^{FH}, b^{FH}\}$.

3.4 Balance of payments

The international investment position and balance of payments identity of the home country are given by the following two equations:

$$z_0^H = f_0^H, \quad z_1^H = f_1^H. \quad (15)$$

The international investment position can be broken down into the following components:

$$f_0^H = e_0^{HF} - e_0^{FH} + b_0^{HF} - b_0^{FH} + m_0^{HF} + o_0^{HF} - o_0^{FH} = -f_0^F. \quad (16)$$

When we differentiate this equation with respect to time, we obtain the financial account and its components. In terms of published balance of payments statistics, $e_1^{HF} - e_1^{FH}$ captures net FDI outflows (part of the foreign direct investment balance) and net equity investment outflows (part of the portfolio balance); $b_1^{HF} - b_1^{FH}$ includes net bond inflows (part of the portfolio balance) and net lending outflows such as loans, trade credits etc. (part of the other investment balance); m_1^{HF} captures net money inflows such bank transfers (part of the other investment balance); and finally, $o_1^{HF} - o_1^{FH}$ represents net reserve inflows (part of the reserve balance).

The current account is the difference between national income on the one hand and consumption and investment on the other:

$$\begin{aligned} z_1^H &= y_1^H - c_1^H - k_1^H \\ &= \alpha(c_1^F + k_1^F) - \alpha(c_1^H + k_1^H) + \sum_i \pi_i w_i a_0^H - \sum_j \pi_j w_j a_0^F + r m_0^{HF} \\ &= -(y_1^F - c_1^H - k_1^H) \\ &= -z_1^F, \end{aligned} \quad (17)$$

where $i \in \{e^{HF}, b^{HF}\}$ and $j \in \{e^{FH}, b^{FH}\}$.

3.5 Exchange rate determination

3.5.1 Nominal exchange rate

The higher the price level of a country is, the lower is the purchasing power of its money and the lower should be its exchange rate (the value of the domestic money in terms of the foreign currency). Here we assume that the nominal exchange rate depends indeed on the reciprocals of the domestic and foreign price levels, which determine the "fundamental" values of both currencies in the absence of added exchange rate pressure. In addition, however, we allow the supply and demand conditions of both currencies in the foreign exchange market to push the exchange rate below or above its "fundamental" level. Specifically, the log exchange rate, $s_0 = \ln(S_0)$, is held to depend on minus the log of the domestic price level, on plus the log of the foreign price level as well as on what we will

call the net accumulated payment inflow, or accumulated cash flow for short, and denote as \hat{m}_0 :

$$s_0 = -(p_0 - p_0^*) + \xi \hat{m}_0. \quad (18)$$

For simplicity, the logarithmic price levels, p_0 and p_0^* , are assumed constant and normalized to zero (an assumption that will be relaxed in section 4.3).

Accumulated cash flow is defined as the net holding of foreign money by both domestic and foreign residents minus their net holding of domestic money. Using equations (3), (4), (15) and (16), we obtain the following:

$$\begin{aligned} \hat{m}_0 &= (m_0^{\text{HF}} + m_0^{\text{FF}}) - (m_0^{\text{HH}} + m_0^{\text{FH}}) \\ &= 4z_0^{\text{H}} + k_0^{\text{H}} - k_0^{\text{F}} - 2e_0^{\text{HF}} + 2e_0^{\text{FH}} - 2b_0^{\text{HF}} + 2b_0^{\text{FH}} - a_0^{\text{H}} + a_0^{\text{F}} \\ &\quad - 4o_0^{\text{HF}} + 4o_0^{\text{FH}}. \end{aligned} \quad (19)$$

Equations (18) and (19) tell us (in their flow versions) that the net appreciation of the domestic currency against the foreign currency is the stronger:

1. the higher the current account balance is,
2. the faster domestic real capital held by domestic residents accumulates and the slower foreign real capital held by foreign residents accumulates,
3. the higher net FDI and equity investment inflows into the home country are,
4. the higher net lending inflows (bonds, loans, trade credits etc.) into the home country are,
5. the slower total assets held by domestic residents accumulate and the faster total assets held by foreign residents accumulate,
6. the more official reserves the domestic central bank is selling and the foreign central bank is buying.

The idea behind equation (18) is that the more foreign money, or the less domestic money, the consumer holds, the higher will be the value of the domestic currency in terms of the foreign currency. In other words, accumulated cash flow measures the scarcity of the domestic currency relative to the foreign currency.

3.5.2 Real exchange rate

The simple model of nominal exchange rate determination in section 3.5.1 implies that the real exchange rate is driven solely by the movements of the accumulated cash flow variable:

$$\begin{aligned} q_0 &= s_0 + p_0 - p_0^* \\ &= [-(p_0 - p_0^*) + \xi \hat{m}_0] + p_0 - p_0^* \\ &= \xi \hat{m}_0. \end{aligned} \tag{20}$$

It should be noticed that in this model—contrary to a widely held belief—price fluctuations do not matter when it comes to explaining the real exchange rate. This is because price movements have two exactly compensating effects on the real exchange rate: rising domestic prices, for instance, push the ratio of domestic to foreign prices up, yet they also lead to a fall in the domestic money’s purchasing power and thus a depreciation of the nominal exchange rate, which just offsets the price ratio increase.

3.6 Generation of boom-and-bust cycles

Boom-and-bust cycles are thought of here as periods of great economic optimism and are modelled as a temporary rise and fall of the return on domestic assets. The section that follows simulates the reaction of the model to the exogenous shift in returns and interprets the findings economically.

4 Simulation of the model

4.1 Parameter choices

According to the first-order conditions in equation (9), the optimal portfolio shares w_i , $i \in C$, $C = \{k^H, k^F, e^{HF}, e^{FH}, b^{HF}, b^{FH}\}$, are functions of asset returns π_i , $i \in C$, asset return volatilities ζ_i , $i \in C$, and asset return correlations η_j , $j \in D$, $D = C \times C \setminus \{(k^H, k^F), (k^F, k^H)\}$. The rise and fall of domestic returns during boom-and-bust cycles lead to transitory adjustments of the portfolio weights.

Given initial parameter values, starting values for w_i result. However, to be able to take into account what is known about international portfolio diversification, it might be desirable to set *initial* portfolio shares exogenously, leaving instead some of the *initial* parameters—say π_i , $i \in C$ —endogenous. The approach taken here is thus to first specify reasonable initial portfolio weights for both representative agents and to then choose ζ_i , $i \in C$, and η_j , $j \in D$, in such a way that realistic starting values for π_i , $i \in C$, result.

Notice, however, that once parameter values with which to start have been chosen, the portfolio weights $w_i, i \in C$, are determined endogenously.

Initially, both countries are in an identical position, so their portfolio compositions match each other. Let the money demand for transactions purposes be normalized to zero. Neither agent holds money at the beginning so that the real capital stock of each agent coincides with his or her net wealth. We also assume that each agent holds the same amount of foreign equity and foreign bonds and that the total sum of foreign assets amounts to half his or her wealth. With these assumptions, the initial portfolio shares are identified as follows:

$$w_{k^H} = w_{k^F} = 1, \quad w_{e^{HF}} = w_{e^{FH}} = 0.25, \quad w_{b^{HF}} = w_{b^{FH}} = 0.25. \quad (21)$$

The formulae for optimal portfolio shares in equations (9) for both the domestic and the foreign agent can now be used to derive the initial returns $\pi_i, i \in C$, provided $\zeta_i, i \in C$, and $\eta_j, j \in D$, are known. Specifically, we use for the volatility parameters:

$$\zeta_{k^H} = \zeta_{k^F} = 0.277, \quad \zeta_{e^{HF}} = \zeta_{e^{FH}} = 0.390, \quad \zeta_{b^{HF}} = \zeta_{b^{FH}} = 0.160. \quad (22)$$

The correlations are chosen as follows:

$$\eta_{j_1} = 0.25, \quad j_1 \in D \setminus \{(k^H, e^{FH}), (k^F, e^{HF})\}, \quad (23)$$

$$\eta_{j_2} = 1.00, \quad j_2 \in \{(k^H, e^{FH}), (k^F, e^{HF})\}. \quad (24)$$

Hence we obtain:

$$\pi_{k^H} = \pi_{k^F} = 5.5\%, \quad \pi_{e^{HF}} = \pi_{e^{FH}} = 5.5\%, \quad \pi_{b^{HF}} = \pi_{b^{FH}} = 1.6\%. \quad (25)$$

The parameter choices are calibrations based on what is known about stock and bond returns. Dimson et al. (2011) have constructed 19-country world indices for equities and long-term government bonds. The countries included in their study covered 89% of the global stock market in 1900 and 83% of its market capitalization by the start of 2011. Over the 111 years from 1900 to 2011, they find that the real value of equities, with income reinvested, grew by a factor of 374.8; the same factor for bonds was 6.1. This translates into an annual real return on the world equity index of 5.5% and of the world bond index of 1.6%. They further show that the world equity index had a volatility of 17.7% per year and the world bond index a volatility of 10.4%, yielding a volatility ratio of 1.70, which is close to the ratios of $\zeta_{k^H}/\zeta_{b^{HF}}$ and $\zeta_{e^{HF}}/\zeta_{b^{HF}}$ of the present model, which are 1.73 and 2.43 respectively. For the correlation between stocks and bonds, Dimson et al. (2011) find that it is generally positive in the 19 countries they consider, with an average of +0.24 over the

period from 1900 to 2011. As figure 6 in Obstfeld & Taylor (2003) shows, the correlation of equity returns in US dollars for the G7 and up to 22 stock markets was also positive during the period from 1800 to 2000, with an average somewhere between 0.20 and 0.40 (with considerable fluctuations though). For simplicity, equation (23) sets all correlations to 0.25; the only exception is the correlation between the returns on capital shared by the domestic and the foreign investor, which is assumed to equal one (see equation (24)).

Regarding the other parameters of the model, the following choices are made: The return on money, r , is zero. The discount factor, ρ , is 0.04. The import factor of both countries, α , is 0.3.

Finally, starting values for wealth at home and abroad, the state variables, are needed. Here, we set $a_{0,0}^H = a_{0,0}^F = 1000$.

4.2 Simulation of boom-and-bust cycles

The simulation of a typical boom-and-bust cycle is based on a discretized version of the model of section 3; to focus on the main dynamics on the model, shocks are set to zero. Time is measured in years, and each year consists of n observations (we choose $n = 100$). Although in reality the duration of lending booms varies, we assume here that both the boom and the bust phase last for four years. We note that in the case of currency crises, the bust phase will typically be much shorter. To get an idea of the behaviour of the variables in tranquil times, we allow for a warming-up and a cooling-off period, each of which lasts four years as well. Altogether therefore, the four different phases—warming-up, boom, bust and cooling-off—span a period 16 years.

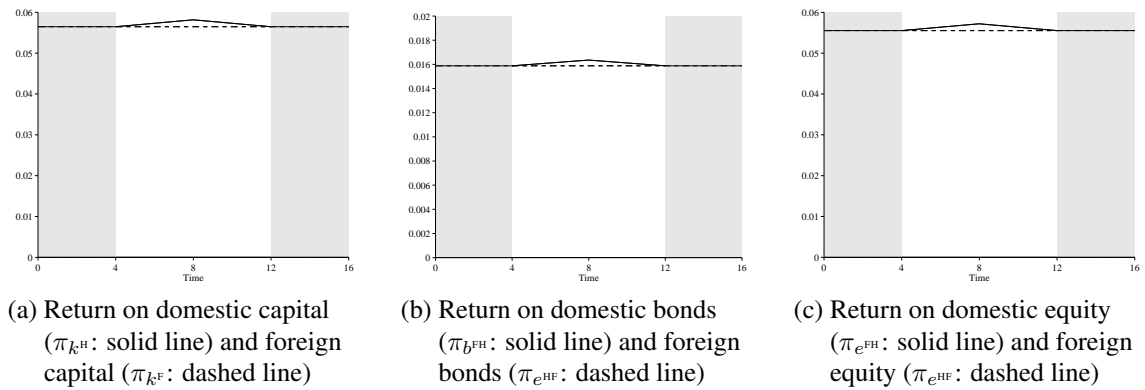


Figure 1: **Asset returns.** Returns on domestic and foreign assets.

If ρ is not too high, the model of section 3 exhibits growth of wealth, consumption, investment, output and national income over time. The boom phase is characterized by an exogenous linear rise of the returns on the domestic assets— k_0^H , e_0^{FH} and b_0^{FH} —to 103% of their respective starting levels; during the subsequent bust phase, returns fall back to

their original levels. This is shown in figure 1. The returns on foreign assets remain unchanged.

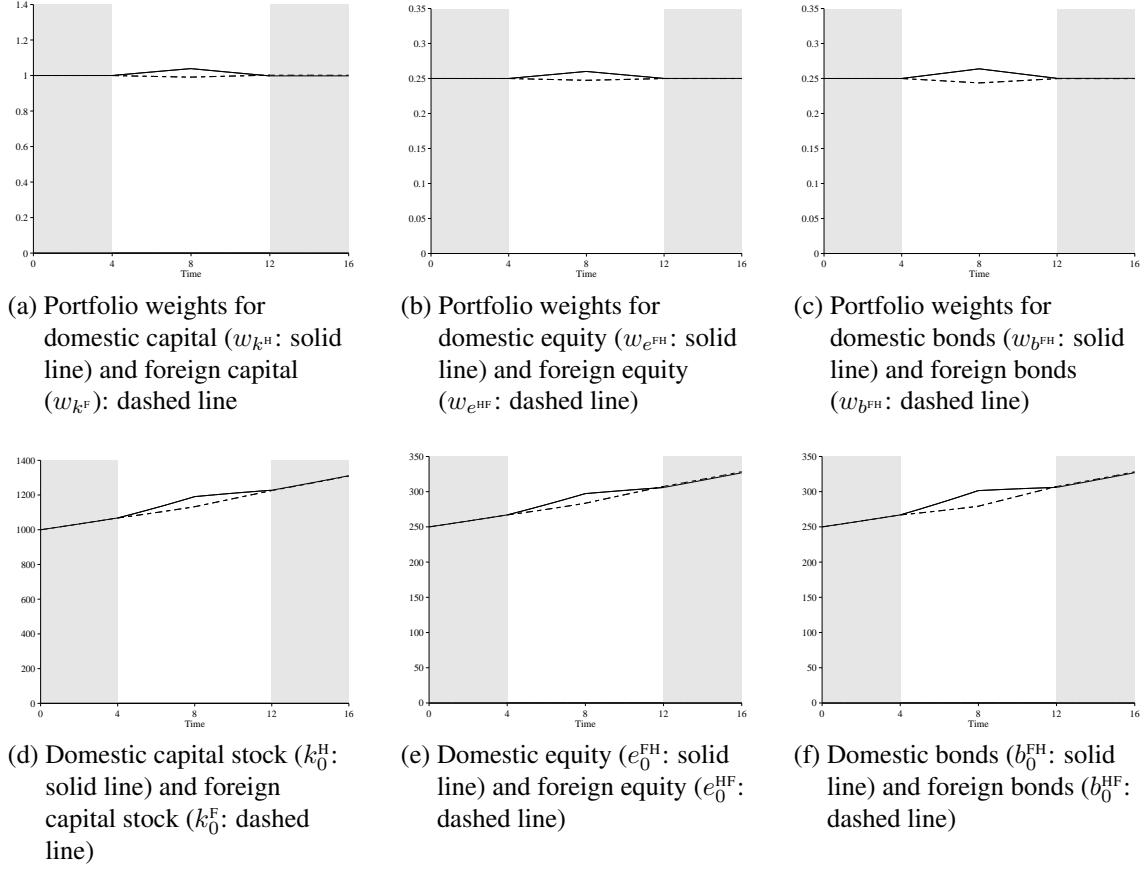


Figure 2: Portfolio allocation. Weights of different assets in the domestic and foreign portfolios (upper row) and total domestic and foreign holdings of different assets (lower row).

The optimal portfolio allocation of the domestic and foreign investors are determined by equation (9). Figure 2 shows that the rise of the domestic returns leads agents to increase the shares of domestic assets in their portfolios. At the same time, the asset correlations in equations (23) and (24) imply that both agents reduce their stakes in foreign assets in an effort to strike the right balance between the overall return and risk.

As a consequence of the rise of domestic returns and the shift towards domestic assets, the stocks of wealth of both the domestic and foreign agents rise more rapidly. This is shown in figure 3.

Figure 4 plots the paths of national income, consumption, saving and investment before, during and after the boom-and-bust episode. Note first that the representative consumer-investors of both countries consume a stable fraction ρ of wealth. By smoothing their consumption spending, they act in accordance with the permanent income theory of consumption. As wealth grows a bit more rapidly, so does consumption. The rise of consumption and particularly that of investment during the economic boom result in a

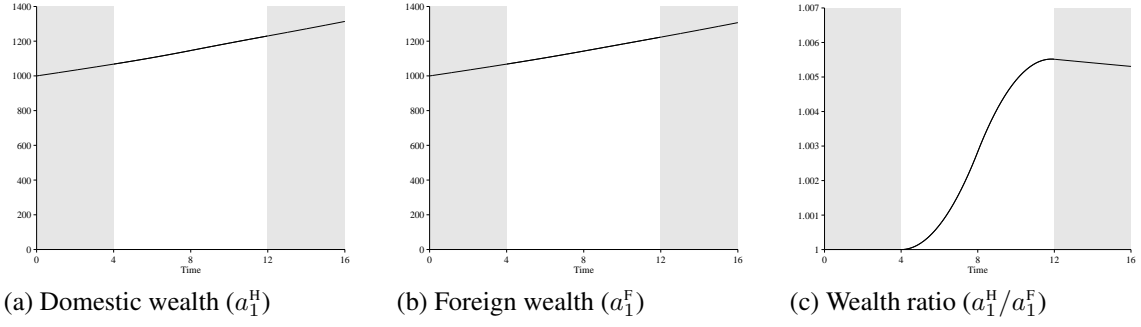


Figure 3: **Wealth accumulation.** Accumulation of domestic and foreign wealth.

surge in output and income according to equations (12) and (14), leading both agents to increase their savings. Conventional intertemporal models of the current account would have the agents invest the additional savings in foreign assets alone, implying zero domestic investment. Yet here it is assumed instead that agents spread their investments between the two countries and the four different asset classes.

The decline of domestic returns implies a very different economic dynamic during the bust phase. Consumption growth is still above average, but the desire of both agents to shift back towards foreign assets results in a sharp fall of domestic investment and a strong increase of foreign investment.

Figure 5a shows the behaviour of the current account during a boom-and-bust cycle. The current account is the gap between national saving and investment, the international investment position the corresponding stock. According to the intertemporal approach to the current account, agents increase their savings in response to a positive income shock and the current account enters into a surplus. Here, however, the result is different, the reason being that the income shock is due to a rise in domestic returns. This rise leads indeed to an increase of domestic and foreign savings, but also to an even greater rise in domestic investment and a fall in foreign investment. As a consequence, the domestic current account enters into deficit (and the foreign one necessarily into surplus).

During the bust phase, the domestic current account reverses in sign and enters into surplus. National income and saving at home is much lower, yet since investment comes virtually to a halt, the difference between saving and investment has a positive sign in the end. Abroad, it is a surge in investment that gives rise to a deficit on the current account.

It is important to stress that the deficit on the domestic current account during the economic boom exceeds the surplus during the subsequent downturn. One reason is that since wealth rises to a higher growth path during a boom-and-bust cycle, so does the domestic capital stock (since it is a fraction of domestic wealth), implying that investment is higher above average during the boom than it is below average during the bust. Another important reason is that the domestic agent has to make higher dividend and interest pay-

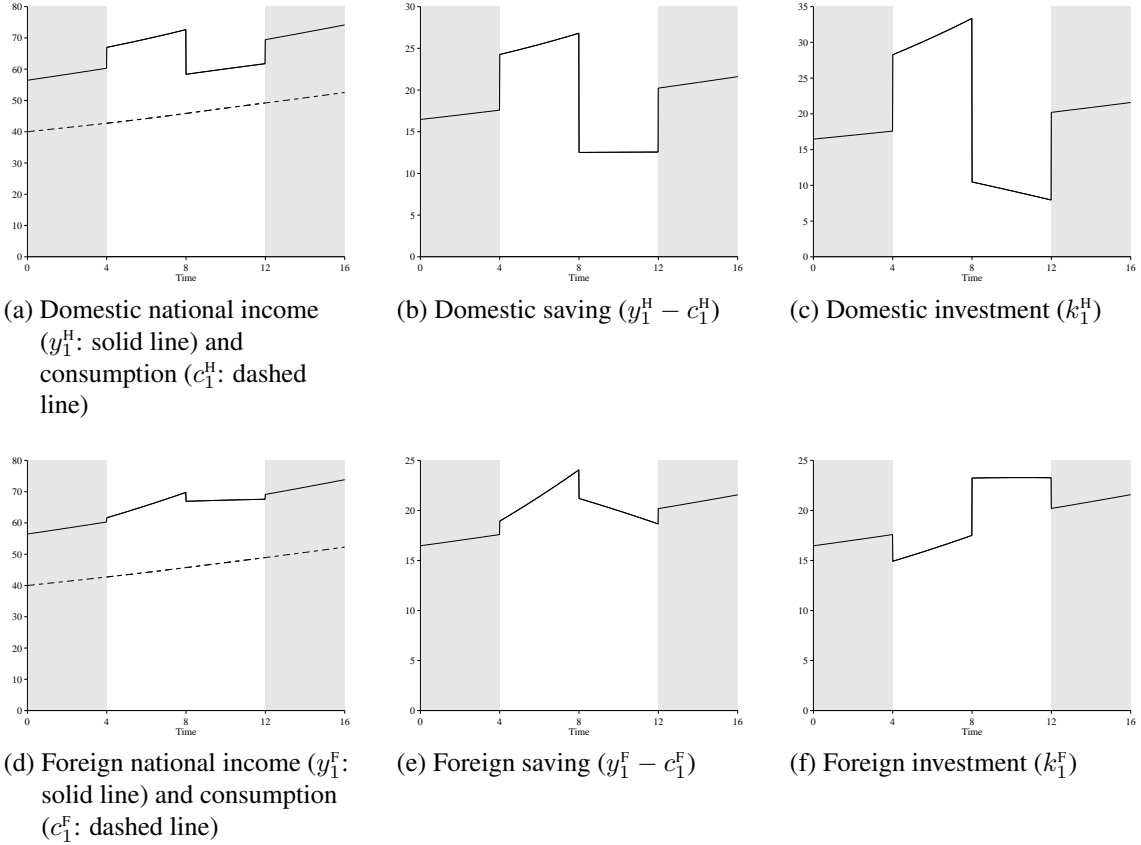


Figure 4: National income and spending. National income, consumption, saving and investment at home and abroad.

ments to its foreign counterpart as a result of the latter's temporarily increased holdings of domestic equity and bonds. As figure 5b shows, the foreign investment position of the domestic consumer-investor thus first falls and then rises during a boom-and-bust cycle, yet it finally settles down somewhat below the level it had initially. As will be shown now, this finding is of great significance when it comes to explaining the behaviour of the real exchange rate.

According to equation (20), the real exchange rate, q_0 , depends positively on the accumulated cash flow, \hat{m}_0 . This latter variable measures the difference between the foreign and domestic money holdings of both consumer-investors. Figures 6a to 6c plot the behaviour of the money holdings before, during and after an economic boom. The behaviour of these variables is best understood by reconsidering equations (4a) to (4d). According to equation (4b), for instance, the amount of foreign money the domestic agent holds, m_0^{HF} , rises initially due to the capital inflows from abroad, despite the decline of the international investment position, z_0^H . Eventually, however, when economic conditions worsen, the combination of capital outflows and a negative international investment position implies an overall fall of m_0^{HF} . Equations (4a) and (4d) can similarly be used to explain the

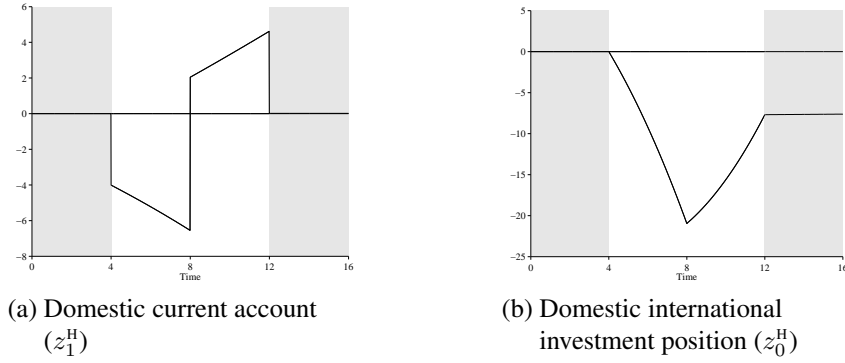


Figure 5: **Current account and international investment position.** Domestic current account and international investment position (or accumulated current account)

behaviour of domestic and foreign money holdings, m_0^{HH} and m_0^{FF} . Here again we see that fluctuations of investment cause a temporary fall m_0^{HH} and rise of m_0^{FF} , yet that in the end it is the international investment position, z_0^H , that dominates.

According to figure 6d, total money holdings, $m_0^{HH} + m_0^{HF} + m_0^{FH} + m_0^{FF}$, eventually remain unchanged. However, as figure 6e shows, the accumulated cash flow—and thus the real exchange rate—first rises, then falls and finally ends up below its initial level.

Figure 6f shows an alternative decomposition of accumulated cash flow, namely one that distinguishes the four components of this variable according to equation (19): the international investment position, z_0^H , the difference between domestic and foreign capital, $k_0^H - k_0^F$, net domestic equity and bond holdings by foreigners, $e_0^{FH} + b_0^{FH} - e_0^{HF} - b_0^{HF}$, and the difference between foreign and domestic wealth, $a_0^F - a_0^H$. While the latter component is relatively unimportant, the second and the third component together are responsible for the initial rise and later fall of the real exchange rate. However, figure 6f also shows that the ultimate overall decline of the real exchange rate is essentially due to the sizeable decrease of the international investment position, z_0^H .

4.3 Nominal exchange rate pegs

Up to this point, it was assumed that neither the domestic nor the foreign central bank intervene. In other words, if we define $\hat{m}_1 = \tilde{m}_1 + \bar{m}_1$, where \tilde{m}_1 is the home country's cash flow before official intervention takes place and $\bar{m}_1 = -4o_1^{HF} + 4o_1^{FH}$ (see equation (19)), then what was assumed is that $\bar{m}_1 = 0$. Note that in this case, $q_1 = \xi \tilde{m}_1$. However, in reality official intervention does take place and central banks often aim or are obliged to stabilize the nominal exchange rate. In what follows, it will be shown that even if the central bank pegs the exchange rate during a boom-and-bust cycle, the accumulated cash flow, and thus the real exchange rate, will still rise and fall, although by a little less than before.

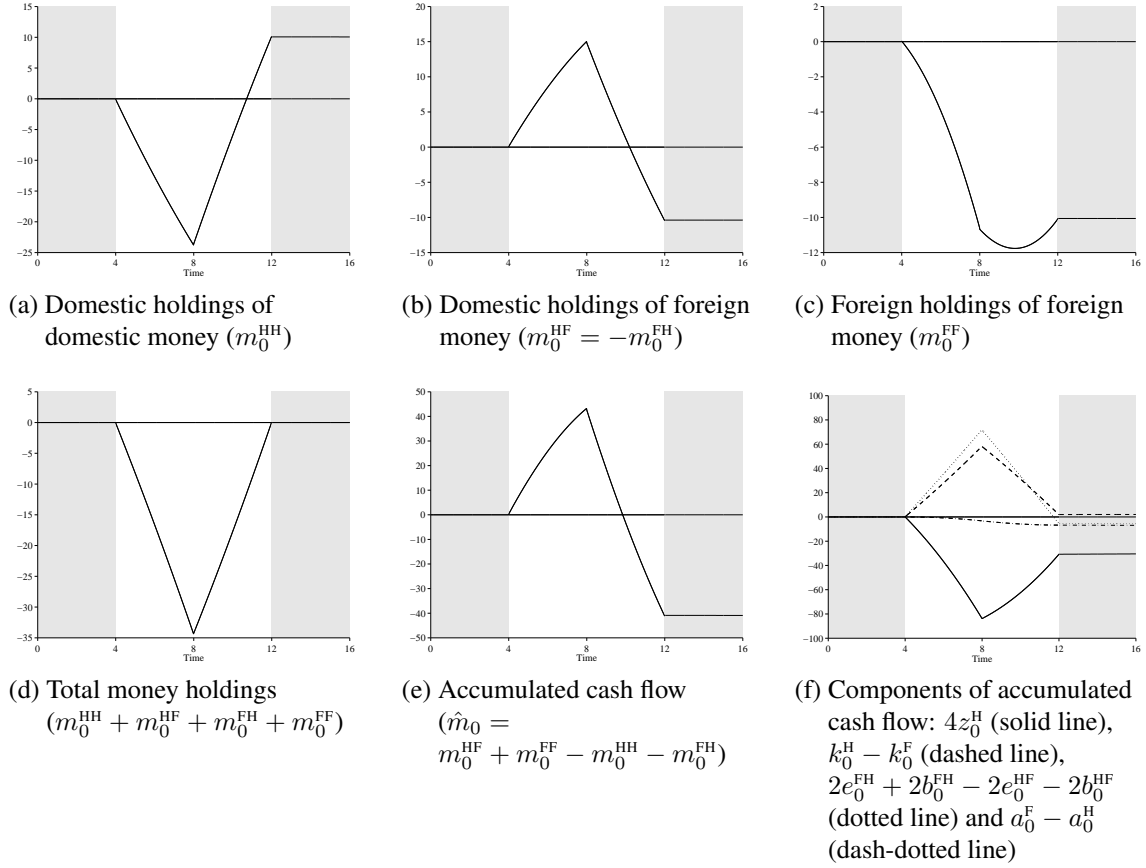


Figure 6: **Money holdings and exchange rate pressure.** Holdings of domestic and foreign monies at home and abroad, total money holdings, accumulated cash flow and accumulated cash flow components (see equation (19)).

Pegging the nominal exchange rate implies that $s_1 = 0$, where we use again the subscript 1 to denote a time derivative. Let us assume that the amount of foreign exchange reserves the domestic central bank has to buy to fix the exchange rate is equal to a fraction λ of the cash flow the home country receives, that is $\bar{m}_1 = -\lambda\tilde{m}_1$. Now it is important to notice that when no sterilization measures are taken (or when the central bank runs out of bonds to sell), the reserve purchases result in a rise of the domestic money supply and a fall of the foreign money supply. Suppose now that these money supply changes translate directly into higher domestic inflation and lower foreign inflation, implying that $p_1 - p_1^* = -\frac{2}{4}\mu\bar{m}_1$, where μ is the money multiplier. Then in summary we have:

$$\begin{aligned}
 s_1 &= -(p_1 - p_1^*) + \xi\hat{m}_1 \\
 &= -\frac{1}{2}\mu\lambda\tilde{m}_1 + \xi(\tilde{m}_1 - \lambda\tilde{m}_1) \\
 &= 0.
 \end{aligned} \tag{26}$$

Hence we obtain:

$$\lambda = \frac{\xi}{\frac{1}{2}\mu + \xi} < 1, \quad (27)$$

since $\xi > 0$ and $\mu > 0$. We see that even when a country fixes its *nominal* exchange rate, the *real* exchange rate will rise and fall during a boom-and-bust cycle since it is now governed by:

$$q_1 = s_1 + p_1 - p_1^* = \xi(1 - \lambda)\tilde{m}_1. \quad (28)$$

To understand the intuition behind this result, it is important to note that official intervention affects the nominal exchange rate through two channels: first by altering the money supply and thus inflation, and second by absorbing part of the cash flow a country receives. Thus if a central bank wants to keep the nominal exchange rate stable, it needs to buy up only part of the inflowing money since the rise in inflation associated with unsterilized reserve intervention will do part of the job to keep the exchange rate down.

5 Case studies

Having analysed the macroeconomic dynamics of boom-and-bust cycles in sections 3 and 4, we now turn to case studies to examine the empirical validity of the theoretical predictions. As we shall see, overborrowing can be observed in different economic contexts, the examples considered here being the Latin American debt crisis of the 1980s, the currency crises of the 1990s as well as countries' macroeconomic reactions to natural resource discoveries. Interestingly, even the two big upswings and downswings of the US dollar since the breakdown of the Bretton Woods system can be explained within the proposed theoretical framework.

Each case study in this section is accompanied by a figure containing time series of the volume of private consumption and investment, capital inflows, the volume of GDP, the current account and the real exchange rate. As explained in the introduction, published balance of payments statistics do not permit the calculation of capital flows between countries. The reason is that these statistics generally do not provide disaggregated data on the "other investment" category of the financial account, which contains loans (including trade credits) as well as money transfers. Thus if, for example, a country has a surplus of \$10 billion in the "other investment" account, this could signify (a) that it simply receives loans worth \$10 billion. However, it could also mean (b) that it receives loans worth \$30 billion as well as \$20 billion in cash payments. Yet another possibility is (c) that it *grants* other countries loans worth \$10 billion, in which case it would experience a net money

outflow of \$20 billion. Since loans form part of capital flows but monetary payments do not (after all, capital inflows involve exports of financial assets, yet money inflows involve imports of such assets), it is thus impossible to calculate the overall volume of capital flows. The solution adopted here is to plot only the sum of net foreign direct investment and portfolio investment inflows in the figures, so as to at least get an idea of the likely direction of capital flows. It should be noted, however, that loans form an important part of capital flows. It is therefore likely that the time series in the figures of this section underestimate by far the true volume of capital flows into and out of the countries considered (especially in the debt crisis of the 1980s where the international obligations of countries affected took mostly the form of long-term commercial bank debt).

5.1 Debt crisis of the 1980s

The international debt crisis of the 1980s broke out in August 1982 when Mexico announced that it could not service its international debt any longer. Other countries in Latin America and other developing regions soon followed suit. Here we examine the case of Mexico as well as that of Chile.

The origins of the Latin American debt crisis are usually traced back to the two oil shocks in 1973–1974 and 1979–1980, which led to a surge in export revenues of the countries of the OPEC cartel. These petrodollars were in large part deposited in western commercial banks, who went on to invest, or “recycle”, them by granting long-term loans to governments of developing countries with good growth prospects. In the late 1970s, not least because of rising inflation, real interest rates were very low and in some cases even turned negative.

However, in late 1979 the appointment of Paul Volcker as chairman of the Federal Reserve marked a turning point. Aiming to tighten the money supply to reduce inflation in the United States, he immediately set out to raise dollar interest rates to historically high levels, causing a world-wide recession. As a consequence, the by now highly indebted countries in Latin America and other regions of the world not only faced higher interest payments and lower export demands, but also lower terms of trade due to the fall in commodity prices. The economic booms that most of these countries were experiencing as a result of the heavy foreign lending thus came to a sudden stop.

5.1.1 Mexico - 1982

Mexico experienced strong growth following a model of import substitution industrialization from 1930 to 1970, a period referred to as the “Mexican miracle”. In the 1970s, its presidents Luis Echeverría Álvarez (1970–1976) and José López Portillo (1976–1982)

pursued policies of economic and social development, for instance through the nationalization of the mining and electrical industries, the redistribution of land and increased spending on health, housing construction, education and food subsidies. The boosts in public spending were facilitated by the discovery in 1974 of vast oil fields and the surge in the price of oil. Towards the end of the 1970s, Mexico started to borrow heavily from international capital markets to invest in the state-owned oil firm *Petróleos Mexicanos* (Pemex).

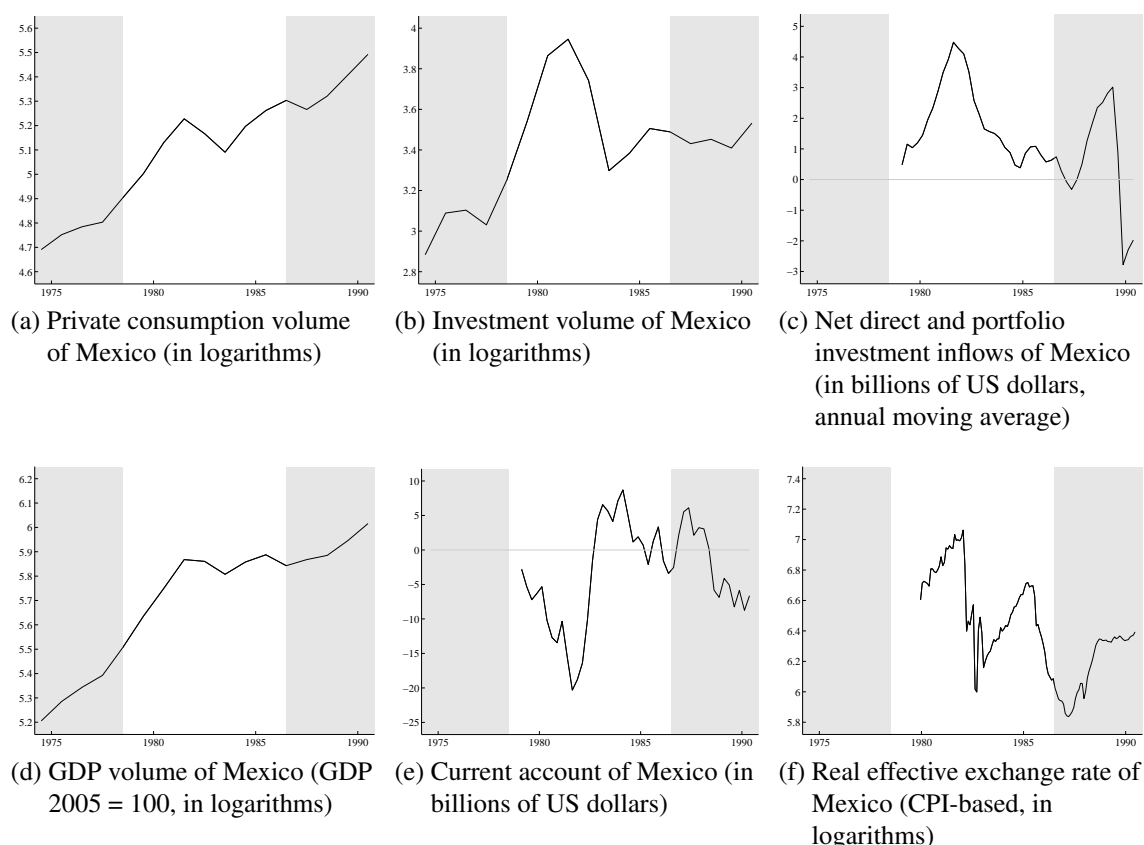


Figure 7: Case study: Mexico - 1982.

Figure 7 gives an impression of how strongly consumption, real investment, external debt and output rose up until 1982. From 1977 to 1981, Mexico's private consumption rose in real terms by 7.6% annually, real investment by 17.2% and GDP by 8.6%. As a consequence of the surge in investment, Mexico was running the largest current account deficit in the world in 1981 (of 135 countries). Nevertheless, the moratorium on foreign debt of August 1982 and the economic and financial crisis that followed implied substantial cutbacks in foreign lending and domestic investment, with the latter falling in real terms by 36.2% between 1981 and 1983. The upshot was an impressive turnaround of the current account, which by 1983 was already recording the world's second-largest *surplus* (of 139 countries).

As our model predicts, the Mexican peso rose in real terms during the boom of the late 1970s yet had to be devalued several times after the 1982 debt default. Although foreign capital in the form of direct and portfolio investment kept on flowing into Mexico after 1982, it did so at a much reduced rate (due to the already mentioned lack of data, we cannot say anything definite about the sign and volume of lending flows to and from Mexico). Albeit a brief relief in 1984–1985, the Mexican real effective exchange rate fell by 50.3% between 1981 and 1987.

5.1.2 Chile - 1982

In 1973, the Chilean general Augusto Pinochet Ugarte overthrew the democratically elected socialist government of Salvador Allende Gossens, setting the stage for a 17-year military dictatorship in Chile. In 1975, Pinochet appointed a group of economists, many of whom had been trained at the University of Chicago under Milton Friedman and Arnold Harberger or at its affiliate at the Catholic University of Chile, to implement market-oriented economic reforms. Given financial and ideological support from the United States and international financial institutions, the so-called Chicago Boys introduced a bundle of measures aimed to privatize the pension system as well as many state-owned companies and banks, to open up the country's current and financial accounts, to consolidate public finances (while cutting taxes) and to stabilize inflation.

Although these changes are said to have worsened the already high income inequality in Chile, they set in motion a remarkable country-wide economic boom. According to the data underlying figure 8, Chile's private consumption rose by 9.2% per annum in real terms between 1976 and 1981, real investment by 15.2% and GDP by 7.5%. Conley & Maloney (1995) provide a vivid account of the "triumphalist" mood of those years. There was a wide-spread conviction that Chile had overcome a decade of stagnation and "in ten years would be a developed nation [...] where 70% of the population would have colour TVs" (labour minister José Piñera Echenique, quoted by Conley & Maloney 1995). With national savings declining (as a percentage of GDP) and national investment soaring, the current account deficit reached a staggering 14.5% of GDP at the peak in 1981. Households and firms took on great debts, often in the form of foreign loans which were easily available and cheaper than the domestic ones. Figure 8c shows that inflows of foreign direct and portfolio investment were sizeable; however, there is little doubt that overall capital flows including foreign loans were much larger still and that they exceeded the deficit on current account during the boom years.

Yet in 1982, not least because of the hike in international interest rates and the overvaluation of the local currency, the boom collapsed. Between 1981 and 1983, real GDP dropped by 16.5%. The private sector found itself deep in debt. Banks were renational-

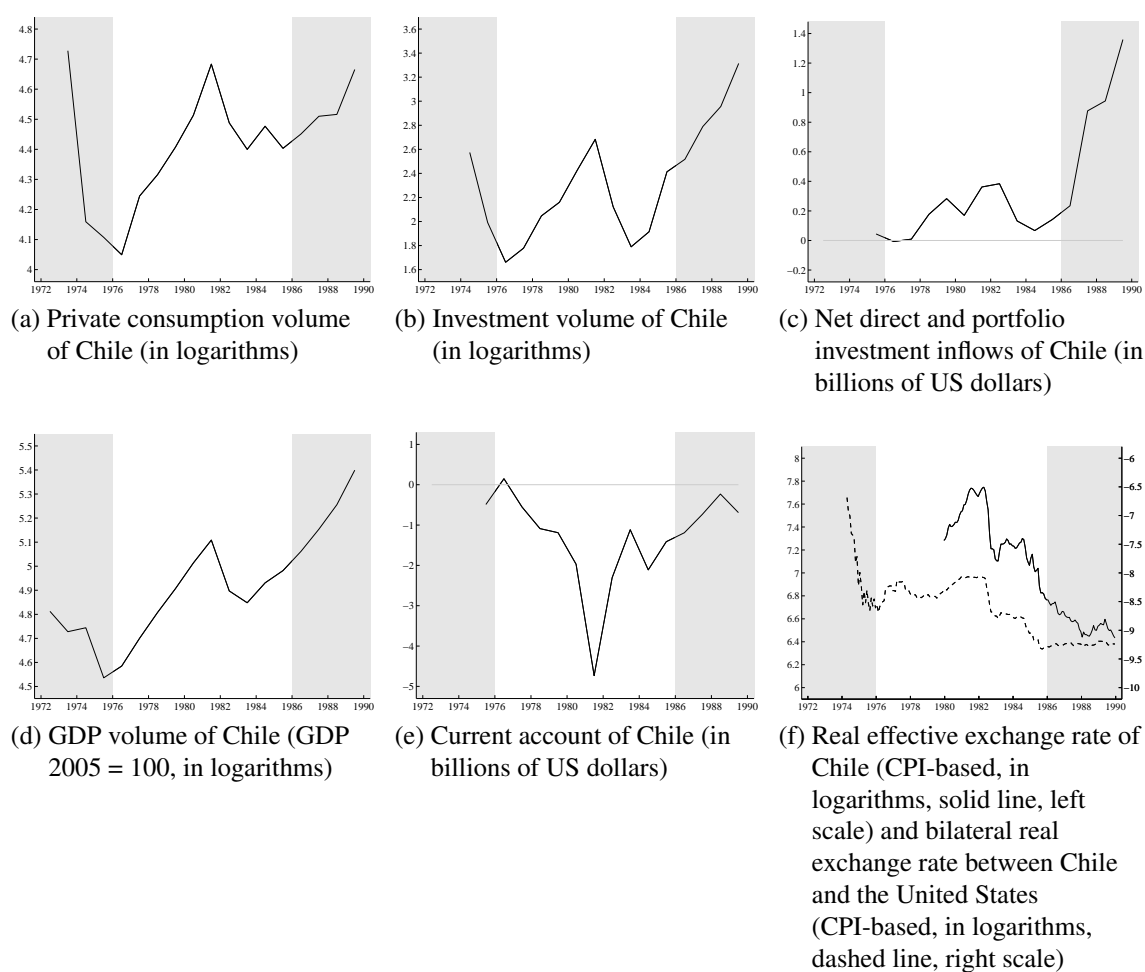


Figure 8: Case study: Chile - 1982.

ized and the up to now healthy-looking public finances deteriorated precipitously when the public sector began to assume large amounts of foreign-denominated private sector debt. This left the government with the largest per capita debt in Latin America (Conley & Maloney 1995).

Not long before the crash, Chile had introduced a fixed exchange rate regime, which it now had to abandon. What is striking is how much the behaviour of the real exchange rate in those volatile years, which is shown in figure 8f, resembles that predicted by our model, which is depicted in figure 6e. Not only did the real exchange rate rise during the boom and fall during the bust, the eventual fall was also much larger than the initial rise: between 1980Q1 and 1982Q1, the real effective exchange rate rose by 30.0%, yet between 1982Q1 and the end of the decade, it lost 58.4%.

5.2 Currency crises of the 1990s

According to most theoretical models of currency crises, the origin of such crises can be traced back to excessive money growth or to fiscal indiscipline (see section 2.2). It is with regard to the immediate causes that these models normally differ (discrete changes in exchange rate expectations, self-fulfilling prophecies, balance-sheet effects etc.). In contrast, the model presented in this article suggests that external imbalances accompanying episodes of large economic expansions and contractions are key to understanding the incidence and severity of exchange rate crises. In the three case studies that follow, we will see that balance of payments imbalances played an all-important role in the collapse of the British pound in 1992, the Mexican peso in 1994 and the Korean won in 1997.

5.2.1 United Kingdom - 1992

The election of Margaret Thatcher as Britain's prime minister in 1979 marked a turning-point for the British economy, which had experienced high inflation and strong public intervention in the 1970s. Adhering (at least rhetorically) to the monetarist and supply-side economics ideologies of the time, her government increased interest rates, pursued fiscal consolidation, cut tax rates for high-income earners, liberalized the financial sector, privatized state-owned industries and crushed the power of the trade unions. In the second half of the 1980s, the British economy experienced a period of strong growth (around 4% in real terms), resulting in a fall of the unemployment rate from 11.8% in 1984 to 7.0% in 1990, and a boom in residential and commercial real estate. In an attempt to bring rising inflation under control, the United Kingdom entered the European Exchange Rate Mechanism (ERM) in October 1990.

Yet in that same year, the "Lawson boom" as it was called came to an abrupt end.¹ As the Conservative government raised interest rates, the economy slid into a recession, which was to last for almost three years and which saw unemployment rise to 10.4% in 1993, almost its pre-boom level. Amidst heavy speculation in the foreign exchange markets, Britain had to abandon the ERM on 16 September 1992 ("Black Wednesday").

In figure 9, Britain's economic upturn in the second half of the 1980s and its subsequent slump are clearly visible. Both consumption and investment rose strongly after 1986, resulting in a sharp fall of the current account. From 1988 to 1990, the United Kingdom recorded in fact the second-largest current account deficit in the world (of 145–146 countries). The boom was accompanied by strong capital inflows (subfigure 9c plots part of them, namely the net inflows of foreign direct and portfolio investment). Consist-

¹ After Nigel Lawson, the Chancellor of the Exchequer from 1983 to 1989.

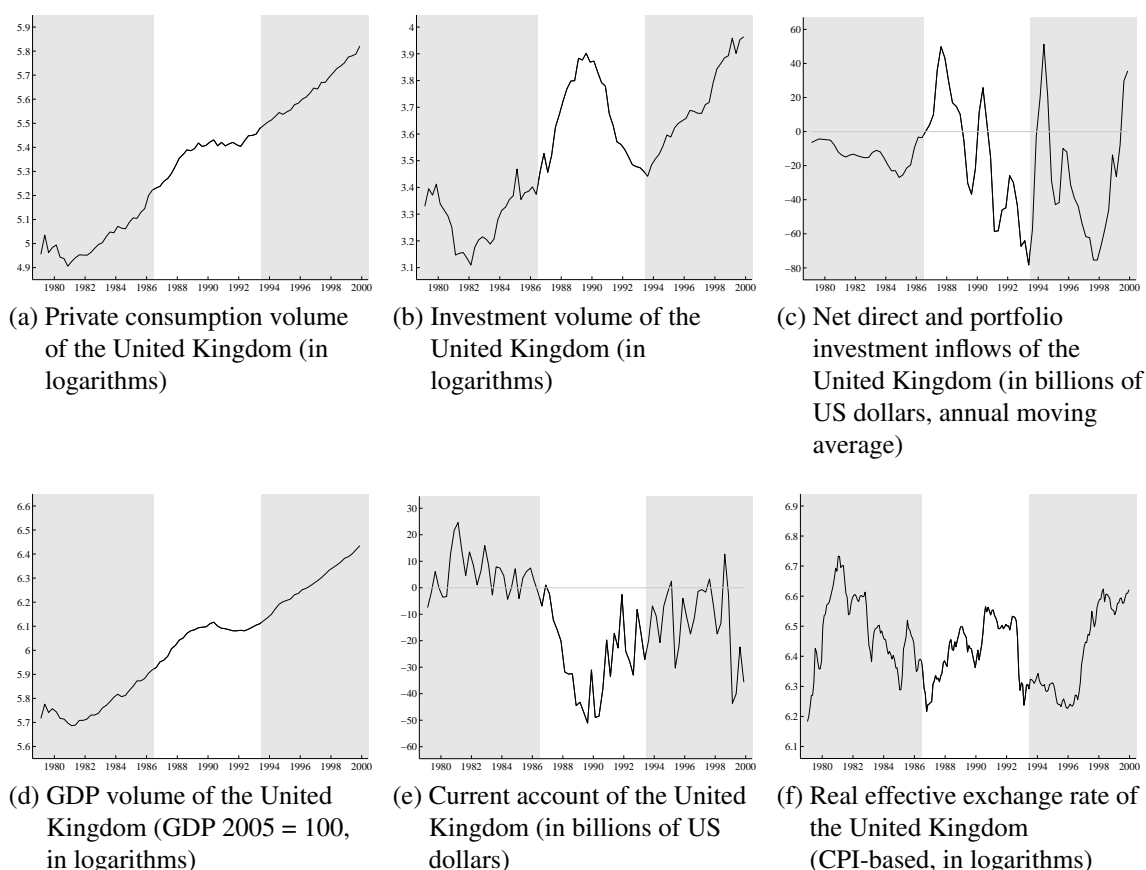


Figure 9: Case study: United Kingdom - 1992.

ent with our theory, the real exchange rate appreciated since mid-1986, when the boom began, yet stayed very low for several years after the devaluation in late 1992.

5.2.2 Mexico - 1994

Mexico's "tequila crisis" of 1994–1995 was preceded by a period of good macroeconomic performance, which followed the implementation of a stabilization programme, privatization policies and structural reforms in the mid-1980s. Capital inflows, which had been very low or negative since the crash of 1982, resumed in 1988 and intensified following the Brady debt reduction agreement in 1989 (Dabós & Juan-Ramón 2000). Between 1988 and 1994, consumption rose by 4.9% per year in real terms, investment by 4.7% and GDP by 3.9%. The downside was a burgeoning current account deficit, which hit 6.8% of GDP two years before the crisis. In 1993–1994, Mexico's current account deficit was the second-largest in the world (of 157–159 countries). All this can be seen from figure 10, which also shows that the country, which was operating a crawling peg with respect to the dollar, saw its real exchange rate almost double in the years leading up to the crisis.

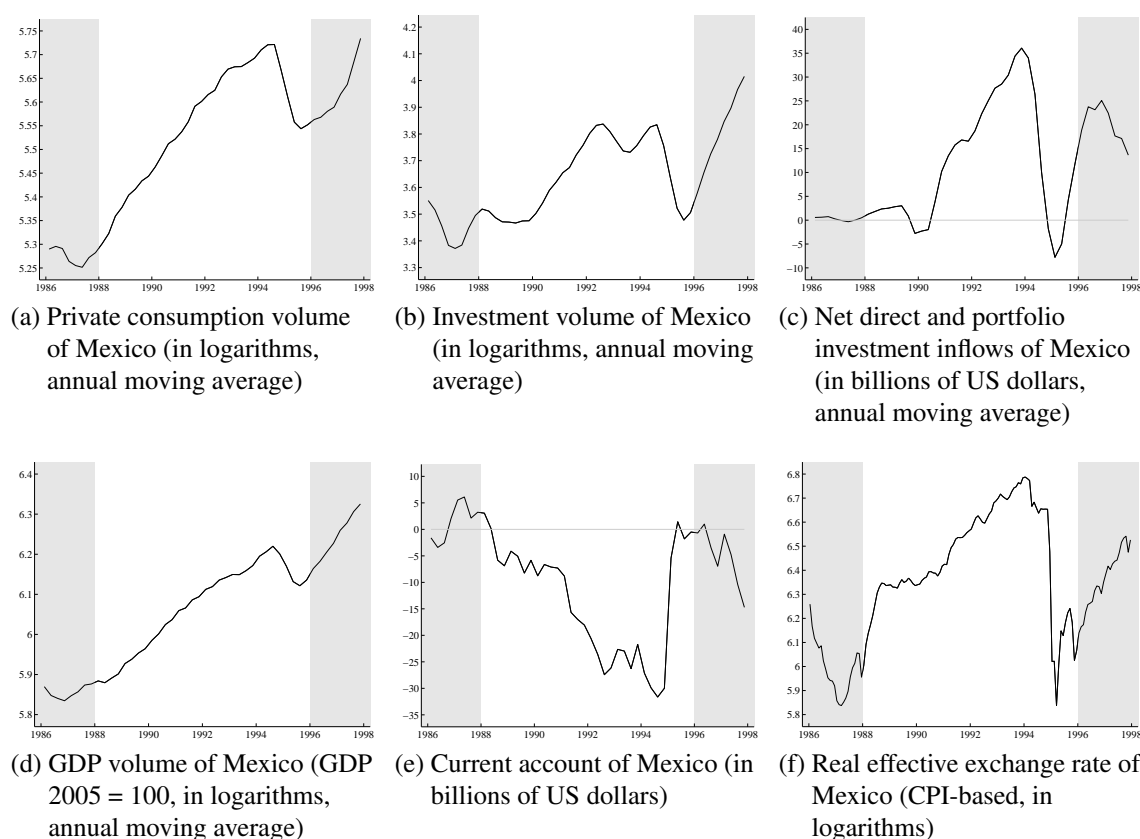


Figure 10: **Case study: Mexico - 1994.**

Yet in 1994, despite the coming into force of the North American Free Trade Agreement between Canada, Mexico and the United States, problems mounted. A series of political events throughout the year—such as a rebellion in the southern province of Chiapas and the assassination of the ruling party’s presidential candidate—raised doubts about Mexico’s political and economic stability (Whitt 1996). To make things worse, US interest rates started to rise in early 1994. Mexico’s central bank found it increasingly difficult to keep the peso within the specified bands. Interest rates rose sharply, while official reserves dwindled. Eventually, in December 1994, the peso was allowed to float, initiating a 50% nominal depreciation over the next six months. In the ensuing recession, GDP fell by 6.2% in real terms during 1995. The situation was exacerbated by the large debts of the private and public sectors and the fact that a large part of the government’s debts were denominated in dollars. Although the real exchange rate recovered fairly quickly after about a year, figure 10f shows clearly its rise during the boom from 1988 to 1994 and its subsequent fall during the bust in 1994–1995.

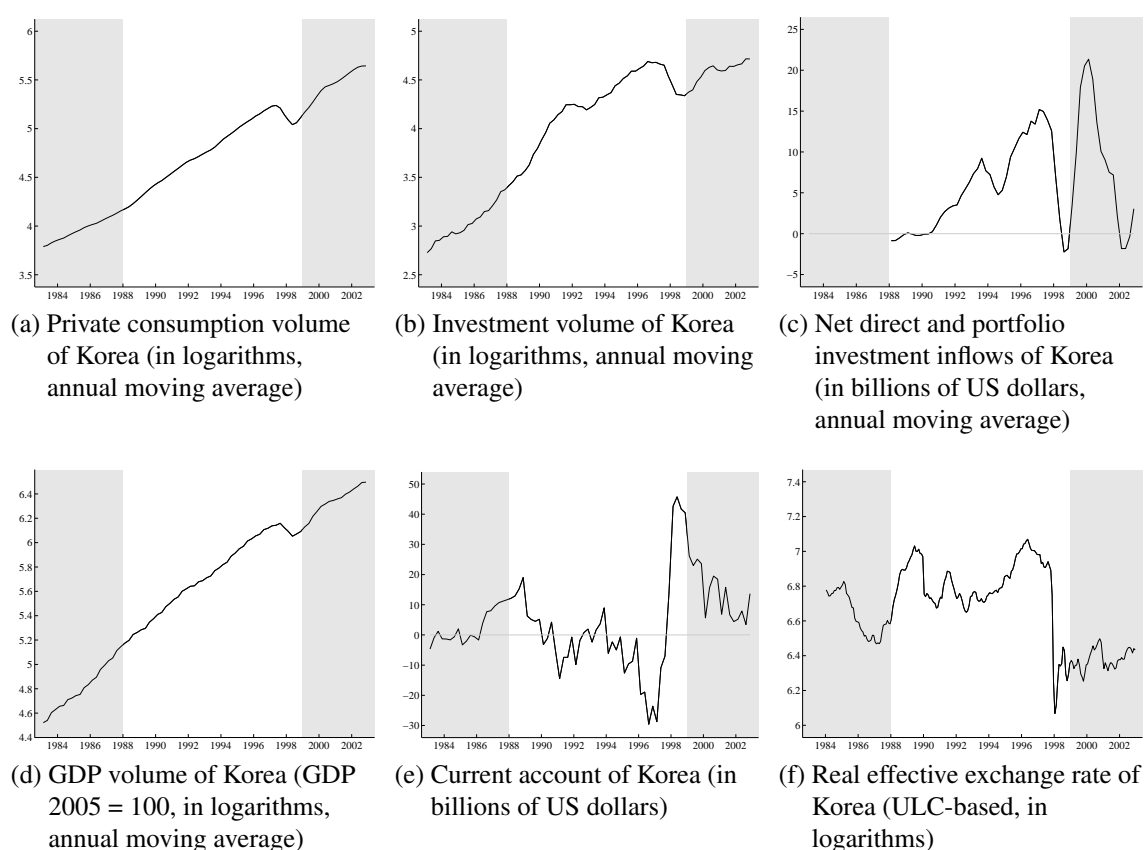


Figure 11: Case study: Korea - 1997.

5.2.3 Korea - 1997

Korea experienced a boom-and-bust cycle before and during the Asian crisis of 1997–1998. Korea's economic growth had already been strong and stable since the 1960s, when the country was one of the poorest countries in the world, yet in the late 1980s it gained even more pace, thanks to a boom in consumption and investment encouraged by strong capital inflows. Between 1988 and 1996, private consumption of households grew at an annualized rate of 8.5% in real terms, investment by firms by 10.9% and overall production by 7.8% (see figure 11). Over the same period, Korea's current account moved from a surplus of 7.7% of GDP to a deficit of 4.3%. From around 1991, however, Korea started to receive capital inflows on an unprecedented scale, allowing the country to finance its external deficit with relative ease and to prop up its foreign exchange reserves at the same time.

The surge in capital inflows, which was experienced similarly by other South-East Asian economies and emerging markets elsewhere at the time, had its origins in internal and external factors (Calvo et al. 1994, 1996, Grenville 1998). On the one hand, the Korean government had recently introduced a series of measures aimed at liberalizing the

country's financial account (for details, see Wang 2002) and, given its high growth rates, the country seemed to offer good investment opportunities. On the other hand, interest rates in the developed world were low in the early 1990s, with US short-term interest rates reaching their lowest level since the early 1960s. Moreover, the importance of institutional investors and mutual funds had increased substantially during the 1980s and early 1990s, as had their willingness to diversify their portfolios towards emerging market economies. Last but not least, banks were in a process of opening up internationally and ready to lend large sums of money to the Asian economies (at the peak in 1995–1996, to the tune of \$75 billion to five South-East Asian economies including Korea, see table 3 in Grenville (1998)).

As capital mobility increased, the Korean government found it increasingly difficult to maintain a pegged exchange rate and thus adopted a managed floating exchange rate regime in 1990 (Wang 2002). Consistent with the theory presented here, the large-scale foreign investments in the first half of the 1990s strengthened the Korean won, which appreciated in real terms by 41.7% between 1986 and 1996. Nevertheless, the large current account deficit meant that eventually the currency had to come down. And in fact, the dollar exchange rate of the won dropped by half in 1997, contributing to a trade-weighted real depreciation of 39.5% of the Korean currency between 1996 and 1998. Finally, it should be noted that the strong improvement of the current account, which our theory predicts as a consequence of turning from boom to bust (see figure 5a), is born out by the data, too. After all, Korea was running the world's third-largest current account deficit in 1996 (of 160 countries), yet only two years later, in 1998, it was running the world's second-largest surplus (of 162 countries, equivalent to 10.2% of GDP).

5.3 Movements of the US dollar since 1973

In the first years after the breakdown of the Bretton Woods system, the US current account and real exchange rate stayed relatively stable. It is since the beginning of the 1980s that both variables show large fluctuations. The current account has been in deficit twice, first during the 1980s and then during the 1990s and 2000s, and in both instances, the dollar experienced a large appreciation, followed by an even larger depreciation. We now look at each episode in turn.

5.3.1 United States - 1980s

In the early 1980s, the United States lived through a severe recession. The recession was primarily the result of a contractionary monetary policy pursued by the Federal Reserve under its chairman Paul Volcker until the summer of 1982. The aim was to control in-

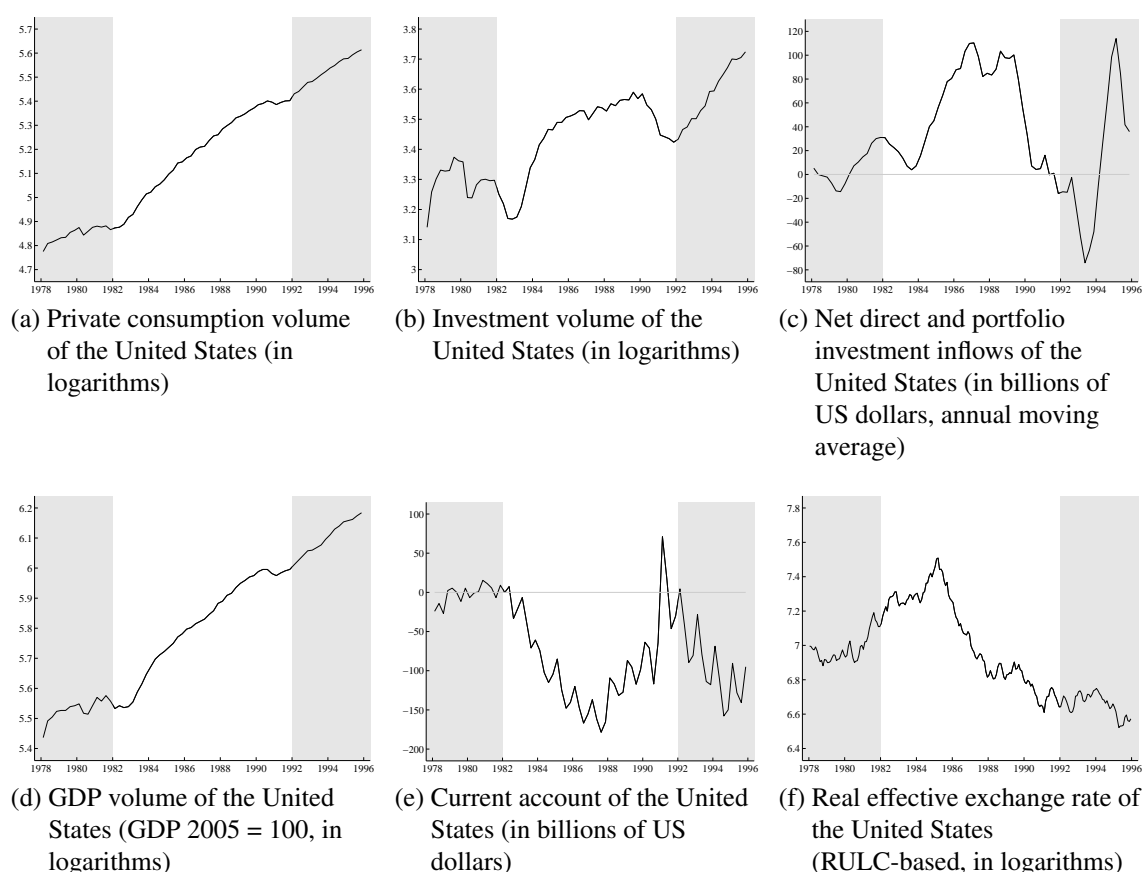


Figure 12: Case study: United States - 1980s.

flation, which had risen to double-digit levels in the wake of the 1970s oil crises. After the official end of the recession in late 1982, the United States experienced a strong economic expansion that lasted for the rest of the decade. Between 1982 and 1989, private consumption in the US rose at an average annual rate of 4.7% in real terms, investment by 3.7% and output by 4.3% (see figure 12). The stock market also went up, with the real US stock market return from 1980 to 1989 totalling 184%.² There is debate over the question whether Ronald Reagan's economic policies—which were based on supply-side economics and a laissez-faire philosophy, yet nevertheless led to large budget deficits due to tax cuts and public spending increases—were responsible for the boom. While many think they are, critics argue that "[the] secret of the long climb after 1982 was the economic plunge that preceded it."³

The model developed in sections 3 and 4 predicts a large current account deficit during the expansionary phase, followed by surplus during the slump (see figure 5a). This is what happened in the United States. From 1983 to 1990, the country run the largest

²The Economist, "I wouldn't start from here: low yields leave investors with difficult choices", 15 October 2011.

³Paul Krugman, "An Economic Legend", The New York Times, 11 June 2004.

current account deficit in the world (of 139–146 countries); at its worst, in 1987, the deficit amounted to 3.4% of GDP. In 1991, however, the United States had the world's eighth-largest current account surplus in the world (of 147 countries).

What is more, the model offers an intriguingly simple and coherent explanation of the "dazzling" movements of the dollar during the 1980s (Frankel 1985). The US real exchange rate rose by about a third between 1980 and 1985, only to fall by two-fifths from its peak value between 1985 and 1992. In fact, it is instructive to put figure 12f showing the actual track of the real exchange rate during the 1980s next to figure 6e showing the predicted movements of the dollar; the two look almost identical.

The dollar's behaviour during the 1980s was exceptional in that a steep and monotone appreciation during half a decade was followed by a steep and monotone depreciation during a similarly long period. At the time, these movements were widely interpreted as a speculative bubble, brought to an end by a secret meeting at New York's Plaza Hotel in September 1985 where G5 finance ministers and central bank governors agreed to co-operate to bring about an "orderly appreciation of the non-dollar currencies" (Eichengreen 1996, p. 149). However, there are reasons to believe that the Plaza Accord was much less consequential than generally assumed. For one, the dollar had already started to decline six months earlier. And, moreover, "no change in monetary and fiscal policies had been discussed at the Plaza, much less undertaken" (ibid.). This article, by contrast, suggests that the sudden turnaround of the dollar in 1985 had to do with the economic boom of the time, which implied that at some point the cumulative capital inflows the United States received had to fall short of its cumulative current account deficit, making a trend reversal inevitable. Economic policy may have played a role insofar as the restrictive monetary policy of the early 1980s and the rising budget deficit of the Reagan administration drove US real interest rates above those of other countries (Frankel 1985, Isard & Stekler 1985, Sachs 1985).

5.3.2 United States - 1990s and 2000s

In the 1990s, the United States' external imbalances re-emerged. Since 1992, the country is running the largest current account deficit in the world (of 151–173 countries). In 2006, the deficit-to-GDP ratio peaked at 6.0%. Between 1992 and 2006, private consumption rose on average by 3.5% per year in real terms, investment by 4.5% and GDP by 3.2%. Capital inflows were strong, with net direct and portfolio inflows by themselves (that is, without other lending flows) being roughly sufficient to finance the deficit on the current account. Considering the graphs in figure 13, it appears that the economic expansion from March 1991 to March 2001, the longest in US history, was followed by another, more moderate expansion in the 2000s. In other words, the early 2000s recession was more

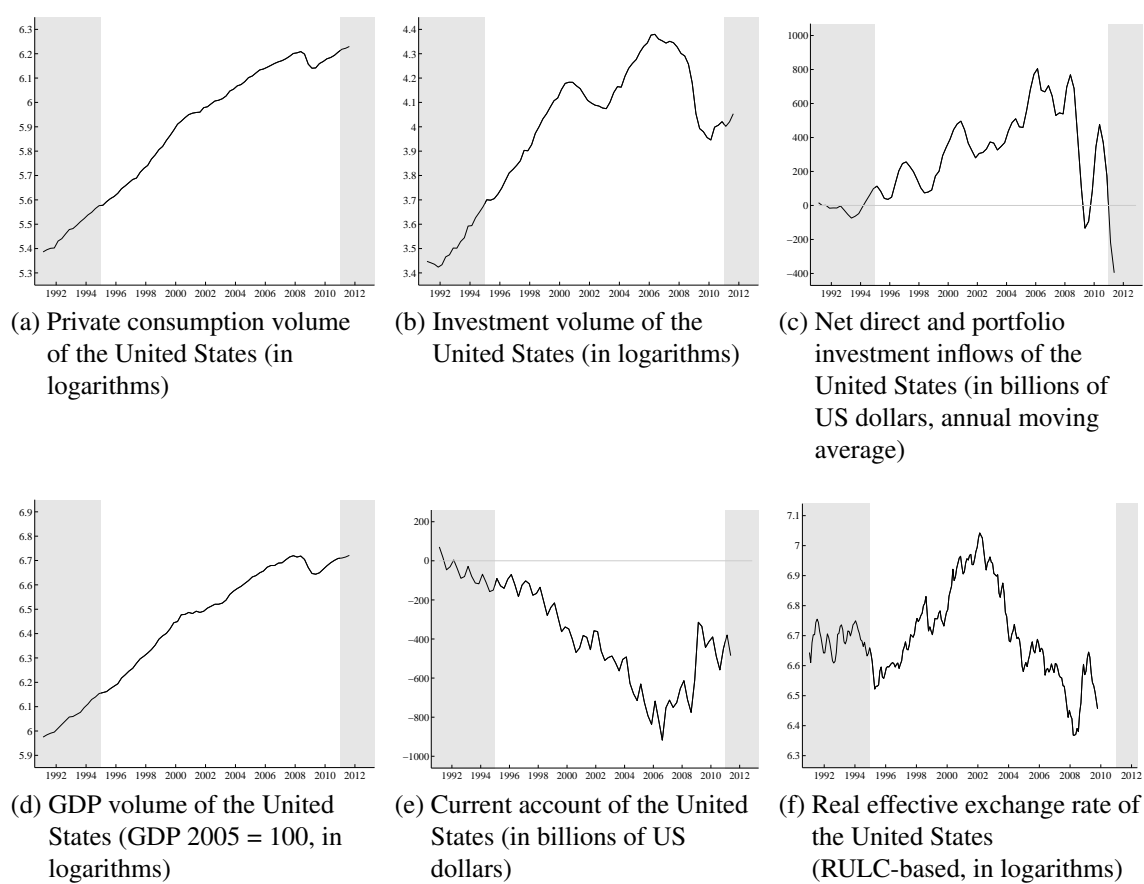


Figure 13: **Case study: United States - 1990s and 2000s.**

a temporary setback than the end of a boom; in particular, consumption and investment remained above their respective trends and capital inflows kept on rising in 2002 after a small correction in 2001. Yet the boom definitely ended in 2007–2008 as the global financial crisis unfolded.

There has been considerable debate over the causes of this long period of economic prosperity in the United States (Ventura 2001). An important question is whether the rapid growth of output and wealth was due to accelerated productivity growth (especially in the IT sector) or whether it was simply the result of a speculative bubble, facilitated by the easy-money policies of the Federal Reserve during Alan Greenspan's tenure. What is certain, however, is that investing in the United States was lucrative during those years. Between 1990 and 1999, for instance, the real stock market return in the United States was 279%, compared to 188% in Britain, 148% in Germany, -42% in Japan and 114% in the world as a whole.⁴

⁴The Economist, "I wouldn't start from here: low yields leave investors with difficult choices", 15 October 2011.

As far as the exchange rate is concerned, we can observe a strong rise of the dollar up until early 2002, followed by a gradual and deep decline thereafter. The US real exchange rate appreciated by roughly quarter between 1992 and 2002, but fell by an even greater amount until the end of the 2000s. To be sure, the evolution of the actual exchange rate in figure 13f is again very similar to that of the hypothetical exchange rate shown in figure 6e.

5.4 Natural resource discoveries

We have already seen in section 5.1.1 how natural resource discoveries can lead to a rise and fall of the real exchange rate. The observation is not new, after all it forms the basis of the Dutch disease, which links the exploitation of natural resources to the decline of the manufacturing sector.⁵ The idea behind the Dutch disease phenomenon is similar to the one presented in this article. The discovery of natural resources in a country, so the argument goes, will lead to a large inflow of foreign currency due to increased foreign investments and larger exports, up to the point where the appreciation of the real exchange rate hampers the international competitiveness of the manufacturing industry. What this article shows, however, is that although the real exchange rate rises initially after a resource discovery, it is set to fall with the passage of time as foreign debt rises.

5.4.1 Norway - 1970–1990

North Sea oil off the coast of Norway was discovered in 1969 and its exploitation on a large scale seemed particularly profitable after the first oil shock of 1973–1974. From that moment on, Norway invested heavily to exploit its oil reserves. The years approximately from 1970 to 1990 are often considered to mark the Norwegian oil boom. During this period, Norway also became a major exporter of natural gas.

Figure 14 shows that Norway actually experienced two consecutive booms in private consumption and investment, one during the 1970s and another, smaller one, which built on the earlier one, during the late 1980s. Each of these booms were associated with a surge in foreign investment and a drop of net exports. In 1977, the current account deficit reached 14.0% of GDP, largely due to increased investment, which had risen in real terms at an average annual rate of 10.6% between 1970 and 1976 (real GDP and private consumption rose by more moderate 5.0% and 4.5%, respectively, over the same period). In 1977, Norway recorded the third-largest current account deficit in the world (of 115 countries), yet by 1980 it was running the ninth-largest surplus (of 132 countries). In 1986–1987, when the second sub-boom started, Norway was again running a current account deficit, this time the ninth-largest world-wide (of 145–146 countries). However,

⁵The Economist, "The Dutch disease", 26 November 1977.

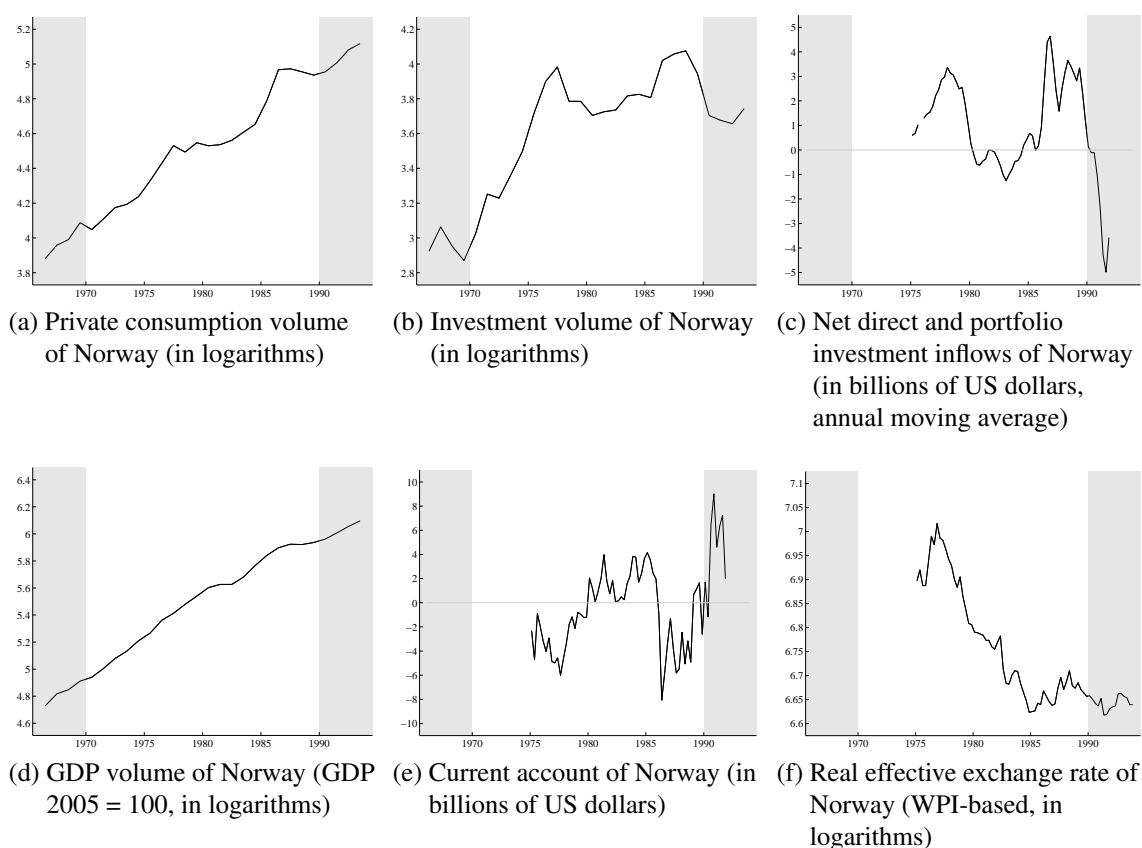


Figure 14: **Case study: Norway - 1970–1990.**

in 1991, when the economic expansion had slowed down considerably, the country was running the fifth-largest current account surplus (of 147 countries). Note that the rapid transitions between current account deficits and surpluses during each of the two sub-booms in response to rising and falling investment opportunities is consistent with the theory presented in this article (see figure 5a). Similarly, the initial real exchange rate appreciation during the early 1970s and later depreciation during the late 1970s and the 1980s is in accordance with the theory put forward here (see figure 6e). Real exchange rate data for the 1970s are incomplete, so we do not know by how much Norway's real exchange rate appreciated initially. But what can be said is that it fell all in all by 21.6% from 1975 to 1991.

5.4.2 Mongolia - since 2006

Mongolia is a country with vast reserves of copper, coal, gold, silver, uranium, molybdenum and other minerals, many of which have been discovered just a few years ago. Since around 2006 it is experiencing a boom in the mining sector. This has led to a steep increase in private consumption, real investment and output, which between 2006 and 2008 grew, respectively, by 13.2%, 30.0% and 14.2% per year in real terms (see fig-

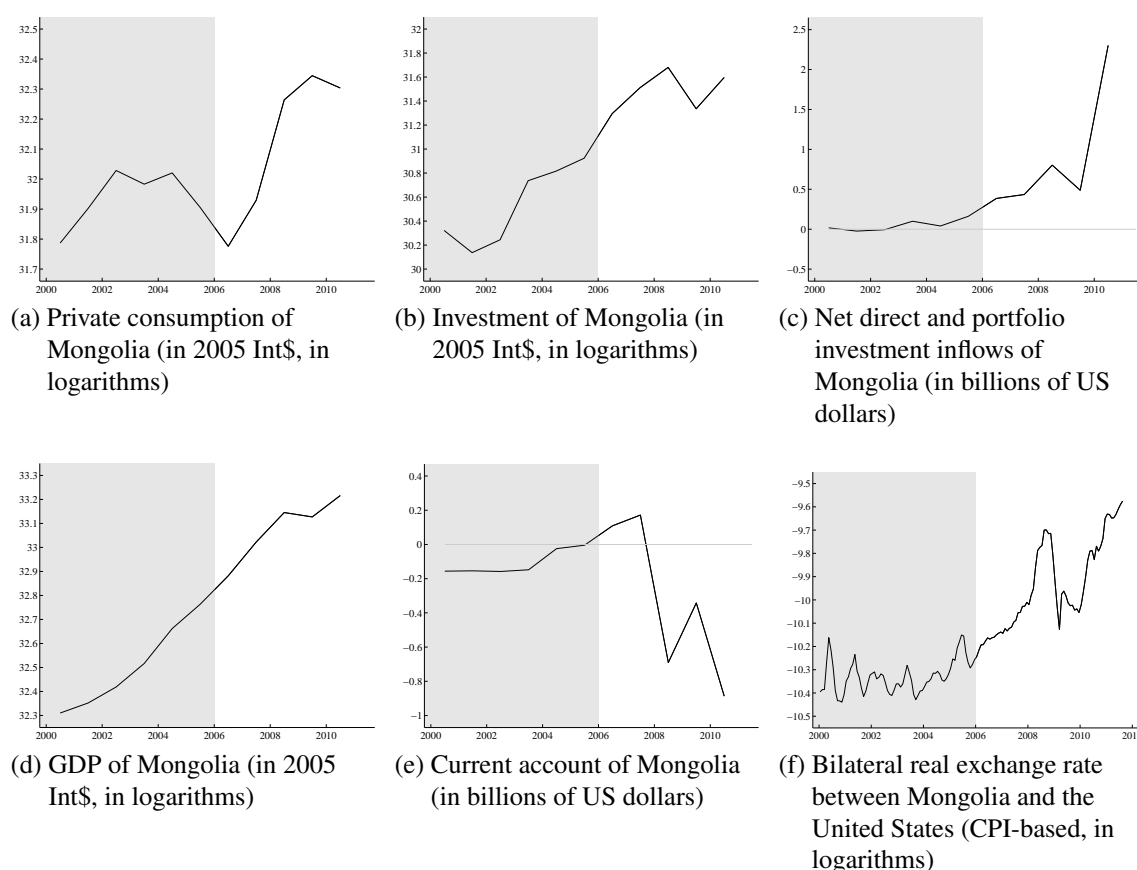


Figure 15: Case study: Mongolia - since 2006.

ure 15). Willem Buiter and Ebrahim Rahbari of Citigroup recently identified Mongolia as one of eleven global growth generators, or 3Gs, countries with the most promising growth prospects for 2010–2050.⁶

Mongolia's biggest development site is Oyu Tolgoi, or "Turquoise Hill", in the Gobi desert, a copper-and-gold mine attracting large sums of foreign investment. It is estimated that by 2013, some \$10 billion will have been spent on it.⁷ For comparison, Mongolia's current GDP is about \$6 billion. By 2020, when production will be fully under way, Oyu Tolgoi should account for one-third of Mongolia's GDP.

Figure 15 shows how the rise in consumption and investment resulted in a burgeoning current account deficit. In 2008 and 2010, the current account deficit was equivalent to 12.9% and 14.9% of GDP, respectively. Yet capital inflows were still stronger. Even if we consider only direct investment and portfolio investment and ignore foreign loans and trade credits, net capital inflows were equal to 14.3% of GDP in 2008 and 36.9% of GDP in 2010. In 2009, sharp drops in commodity prices and the effects of the global financial

⁶See Wikipedia article on the 3G countries at [http://en.wikipedia.org/wiki/3G_\(countries\)](http://en.wikipedia.org/wiki/3G_(countries)), accessed on 29 February 2012.

⁷The Economist: "Booming Mongolia: mine, all mine", 21 January 2012.

crisis caused a slowdown, yet by 2010 the economy was again as dynamic as before. Even the 21% drop of the local currency against the US dollar between 2008M12 and 2009M3 did not stop the surge in relative domestic prices: in 2010, the bilateral real exchange rate between Mongolia and the United States was up by 28.4% since 2006 and by 46.8% since 2003 (see figure 15f). However, this article's prediction is that even if growth remains strong, the piling up of foreign debt means that ultimately the real exchange rate has to come down.

5.4.3 Brazil - since 2007

In 2007, Brazil's state-controlled energy corporation Petrobras and other oil companies started to discover vast oil reserves in the so-called pre-salt ("below the salt") layer off the coast of Brazil. Before the finds, Brazil's total proven and probable oil reserves were 20 billion barrel. According to conservative estimates, however, total recoverable pre-salt oil amounts to at least 50 billion barrel. Hence it is likely that the country, which currently ranks eleventh among the world's oil producers, is in the top five by 2020. The development of the pre-salt oil fields is forecast to cost a trillion dollars over the first ten years, around half Brazil's 2010 GDP. Petrobras itself is set to spend \$45 billion a year for the next five years, the largest investment programme of any oil firm in the world.⁸

Even before the oil bonanza, Brazil's economy was vibrant and fast-growing. Yet as the time series in figure 16 show, domestic investment and foreign lending have soared right after the oil finds. Brazil's current account, which recorded a surplus between 2003 and 2007, entered into deficit in 2008. Although the deficit did not seem too high in relative terms by 2010 (2.1% of GDP), it was nevertheless the ninth-largest in the world (of 152 countries). All variables of figure 16 took a hit during the 2008–2009 global downturn, yet soon regained their previous rapid pace. This is true in particular for Brazil's exchange rate. Between 2006 and 2010, Brazil's foreign exchange reserves increased by 230%, but this did not prevent the nominal and real effective exchange rates to rise by 21.6% and 31.0%, respectively, over the same period. Since there are no signs as yet of Brazil's oil boom losing momentum, a continued rise of the real exchange rate is quite possible in the light of the theory set out in this article. Some day though, when growth slows down, Brazil should be prepared for an even greater fall of its currency.

⁸Data in this paragraph are taken from: The Economist, "Brazil's economy: the devil in the deep-sea oil" and "Brazil's oil boom: filling up the future", 5 November 2011.

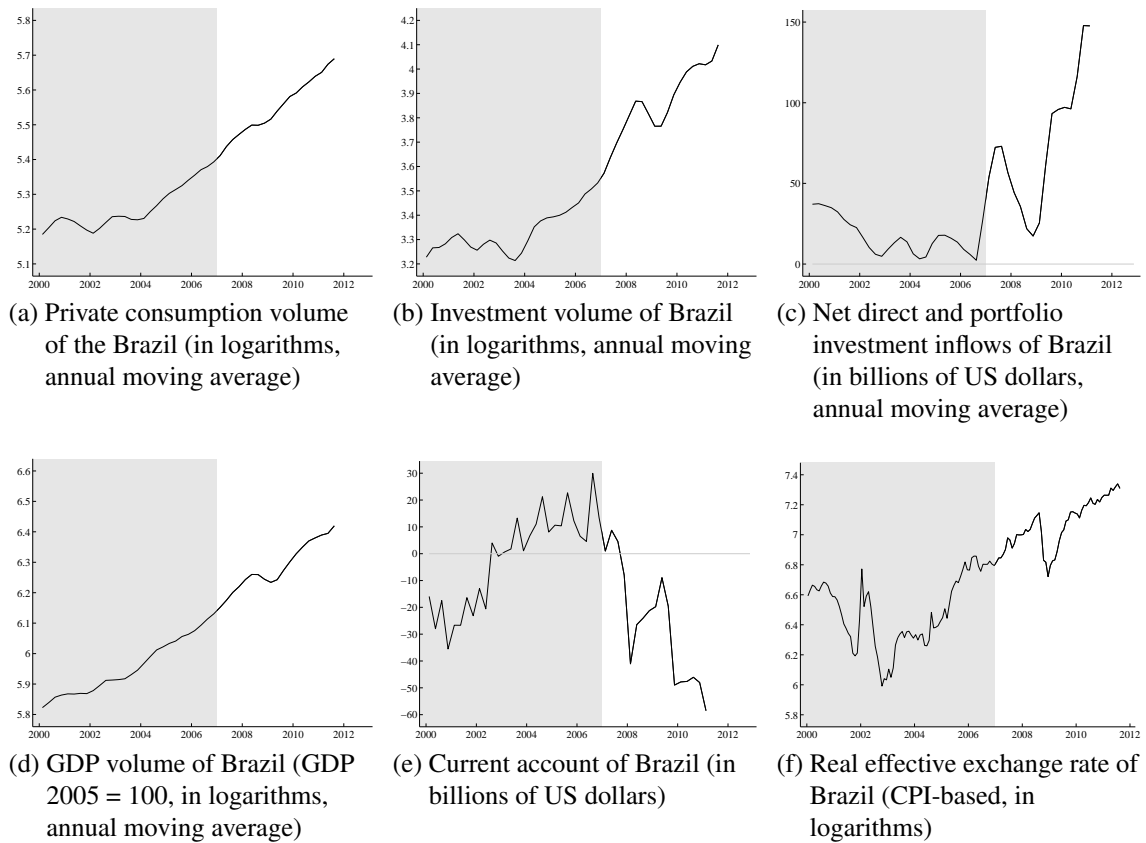


Figure 16: **Case study: Brazil - since 2007.**

6 Conclusions

The objective of this article has been to explain the macroeconomic dynamics of boom-and-bust cycles and in particular the movements of the real exchange rate during such episodes. A model of optimal consumption and portfolio choice has been used to demonstrate how national income and spending as well as the balance of payments respond to an economic boom provoked by a temporary rise of domestic asset returns. The model predicts a moderate rise in consumption and a strong surge in investment during the initial expansion, accompanied by strong capital inflows and a steady deterioration of the current account. When domestic returns revert to their initial levels, however, domestic investment falls sharply and foreign investors pull out their stakes, too. Although the current account enters into surplus and the international investment position improves, the latter variable ends up at a lower level than at the beginning due to the increased dividend and interest payments the country has to make.

The main question the article addresses, however, is why the real exchange rate tends to first appreciate and then depreciate during boom-and-bust cycles. It is shown that if the nominal exchange rate depends on the domestic and foreign price levels as well as

on the demand pressures in the foreign exchange market, the real exchange rate is, by its definition, entirely explained by the latter. The demand conditions in the currency market are assumed here to be related to the amounts of the domestic and foreign monies the representative agents hold, such that when the agents obtain a large amount of a given currency, that currency will depreciate.

Based on this simple assumption, the explanation of the real exchange rate behaviour during boom-and-bust cycles is straightforward. During the initial economic expansion, capital inflows exceed the deficit on the current account, pushing the exchange rate up. During the subsequent downturn, however, foreign capital is drawn back, and together with the overall fall of the international investment position this implies a sharp real depreciation. Such dynamics can be observed not only in countries with fixed exchange rates, which often tend to experience outright currency crisis during the economic downturn, but also in countries that let their exchange rates float.

Although simple and intuitive, the explanation of real exchange rate fluctuations put forward here is a no-no in the theoretical literature on exchange rates, which—despite the empirical criticism put forward by Engel (1999)—still relies on the relative price of non-traded goods as the main determinant of real exchange rate changes. However, this article shows in a number of historical case studies that there is much empirical evidence in favour of the view that real exchange rates are driven by currency movements brought about by balance of payments fluctuations.

This article is only a first step towards linking currency flows and exchange rate movements. Further research would be desirable, particularly on the role of economic policy during economic booms. In order to keep the analysis simple, this article has also ignored the possible feedback of the real exchange rate on the trade balance and thus the current account. Presumably, the real exchange rate appreciation that accompanies economic booms leads to a further worsening of the current account, provoking an even larger fall of the exchange rate later on. At a more general level, it would be interesting to investigate the connection between persistent external imbalances, currency movements and the long-term behaviour of exchange rates.

Appendix A Solution details

This section shows how to solve the problem of the representative consumer-investor in equations (2) and (6). The first one to solve this kind of problem was Merton (1971). A particularly intuitive way to solve the problem, however, is the method of symmetry (see Chang 2004). The idea behind this method is that it is sometimes possible to carry out a change of variables that affects the objective function but leaves the law of motion of

the problem invariant. Such a transformation is called a symmetry since the dynamics of the model is left unchanged. If the transformed objective function can be related to the objective function of the original problem, then it is possible to ascertain the functional form of the value function.

In the present context, the objective function is given by equation (2) and the law of motion governing the dynamics of the model by the controlled diffusion process in equation (6). Suppose wealth is doubled at all times, both at home and abroad. Intuition tells us that consumption by the domestic and foreign consumer-investors should be doubled at all times, too. If we further assume that the shares of all assets remain unchanged, then we are in effect considering the following transformation:

$$\Psi(a_0^H, a_0^F, c_1^H, c_1^F, w_i) = (\psi a_0^H, \psi a_0^F, \psi c_1^H, \psi c_1^F, w_i), \quad (29)$$

where $i \in \{k^H, k^F, e^{HF}, e^{FH}, b^{HF}, b^{FH}\}$.

This leads to the following transformed financial constraint of the domestic consumer-investor:

$$\begin{aligned} \psi a_1^H dt = & \left(\sum_i (\pi_i - r) w_i \psi a_0^H - \sum_j (\pi_j - r) w_j \psi a_0^F + r \psi a_0^H - \psi c_1^H \right) dt \\ & + \sum_i w_i \psi a_0^H \zeta_i d\omega_i - \sum_j w_j \psi a_0^F \zeta_j d\omega_j. \end{aligned} \quad (30)$$

where $i \in \{k^H, e^{HF}, b^{HF}\}$, $j \in \{e^{FH}, b^{FH}\}$. The transformation described in equation (29) is a symmetry since the transformed law of motion in equation (30) describes the same dynamics as the initial law of motion in equation (6) (and the same for the foreign-country counterparts of the respective equations).

Using this symmetry, the transformed objective function is:

$$\mathbb{E} \int_0^\infty e^{-\rho t} \ln(\psi c_{1,t}^H) dt = \mathbb{E} \int_0^\infty e^{-\rho t} \ln(c_{1,t}^H) dt + \frac{1}{\rho} \ln(\psi). \quad (31)$$

It follows that:

$$V(\psi a_0^H) = V(a_0^H) + \frac{1}{\rho} \ln(\psi). \quad (32)$$

Setting $\psi = 1/a_0^H$, this leads to:

$$V(a_0^H) = \frac{1}{A} \ln(a_0^H) + B, \quad (33)$$

where $A = \rho$ and $B = V(1)$.

Appendix B Variable definitions and data sources

All time series shown in the figures are taken from the International Financial Statistics of the International Monetary Fund, the only exception being the data on GDP, consumption and investment of Mongolia, which are from the World Development Indicators of the World Bank. Years start at the axis ticks of the corresponding year. All logarithms in the article are to the base 2. The GDP volume indices are all equal to 100 in the base year 2005 and their base 2 logarithms thus equal to 6.63 in that year. Consumption and investment volumes are calculated by multiplying the share of, respectively, nominal consumption and nominal investment with respect to nominal GDP with the GDP volume indices of the countries in question. Yearly moving averages of quarterly series are calculated as the unweighted arithmetic means of the 3-period and 5-period symmetric moving averages. Quarterly data of the current account and capital flow series are multiplied by 4 to allow easy comparison with countries where only annual data are available.

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